A RESEARCH DELUSION[1]

..... Interest is centered in output rather than in quality. This is just another characteristic symptom of megalomania, so prevalent in our day in most lines of endeavor. . . I think that on an occasion of this kind a brief period can be profitably spent in analyzing the present tendency in research in order that we may have a better understanding of what actually constitutes research.

Research consists of more than the mere accumulation and publication of facts. Research in its highest aspect is something creative, akin to the well-known masterpieces of art, music and literature. A masterpiece is the product of the artist's mind, in that any one using the same oils and paints could not create a similar picture. The same creative urge is shown in music and literature. It is true that the scientist can not create any new material thing, but neither does the painter use anything in the way of materials other than those available to any one. However, the master scientist can so arrange his materials and facts that they represent a fundamental contribution to science as a painting does in art. As in art a masterpiece may go unnoticed for years, so in science the true value and significance of a contribution may escape attention for decades, but once its proper value is ascertained it persists for ages.

It is rather disconcerting to listen to classical music and to realize suddenly that the melody transposed and in quickened tempo forms the basis of the latest jazz hit. The same feeling comes over one after reading an article to find that, although some new data are added, it is just a transposed rendition of some old familiar contribution. As in the arts, music and literature there are too many imitative and not enough creative minds. It is impossible for us all to become creative scientists, but we should at least strive towards this goal.

The English cleric who recently suggested that all active research be abandoned, for a period of ten years, had in mind, I think, that too much work was being repeated and the period of inactivity would bring us to a realization of the futility of doing research without an adequate understanding of what has previously been accomplished. An analysis by a master in his field of all existing data in his specialty would advance research much faster than the addition of more data during this period. As a merchant takes stock once a year and balances his accounts to see what progress has

[1] Address of the past president of the Nebraska Academy of Science, Fremont, Nebraska, April 27, 1928.

been made, so should we take stock at intervals of all the endeavors in our special field of science. A carefully digested inventory of the investigations in our field can not but lead to research of a higher standard. Not only do we fail to digest properly the publications of previous workers, but we are so intent on the mere collection of data that we do not take the time to weigh our data in their broad relationships.

It is true that from an economic standpoint the collection of new facts has yielded large returns, but soon, unless some precautions are inaugurated, having been so thoroughly sold on the benefits of scientific endeavors, the public will expect the impossible. Have the contributions of science to the progress and development of civilization made us a better and more cultured people? Scientific discoveries have no doubt given us more leisure than the world has ever known before. Are we producing any great works of art, music or literature in our times as the result of this leisure?

Perhaps at this point it might be well to review the history of science and attempt to determine how fundamental discoveries were brought to fruition. It is well known how the philosophical theories of Aristotle permeated the thought of Europe for centuries. While many of Aristotle's observations are sound, his deductive reasoning on natural phenomena probably more than any other factor held in abeyance the adoption of the experimental or inductive methods in science. Galileo, on the other hand, after much thought propounded his theory of falling bodies and was able to prove experimentally that his deductions were correct. The discoveries of Newton, Faraday and others are very striking in that they propounded fundamental laws on what would now be considered very meager data. I am inclined to believe that their profound knowledge of mathematics was a great aid in arriving at the conclusions they did with so little data. Darwin, however, went to the opposite extreme and amassed a large amount of data over a long period of years before he announced his theory of the origin of species. One could cite numerous examples of the thought that was given to the interpretation of data before it was offered for publication.

The present tendency is to accumulate a super-abundance of facts and data and devote too little time and effort in the proper correlation and interpretation of them. It is high time that we do relatively more thinking and less investigating if we are to maintain the high standards which have been set up for us by the past masters of science.

How are we to attain the goal of creative research? This question can not be answered any more easily than one can explain the production of a masterpiece in art, music or literature. However, it is possible to discuss some of the avenues which might lead to creative research. I am sure that when we began our careers in the sciences we were prompted to do so either through curiosity, humanitarianism, personal vanity, imitation or some such motive. Whatever this urge might have been originally, without it I doubt if any of us would spend the energy we do in research.

In more ways than one this incentive is like a mirage, always in the distance, but for some reason or other we are never quite able to catch up with it. This failure to catch and hold a creative thought is partly due to the fact that we are not real dreamers or good philosophers. We are so busy collecting facts that we fail to give them much thought. Have you ever analyzed where your ideas originate? You will frequently find that it is during moments of relaxation, when the problems demanding your working energy are farthest from your thoughts. It is seldom that the most constructive thinking is done while busily engaged in the laboratory. More relaxation and reflection would be much more advantageous in solving problems than the mere collection of more data. With relaxation and reflection our subconscious mind might function and flash to us in an instant the clues which we were vainly groping for while in the laboratory.

Even if we ourselves fail to do creative research we can stimulate the rising generation of scientists to hunger for the goal and in this fashion make our contribution to the advancement of science. It should be the chief aim of the teacher in his contact with students to direct and stimulate them to thinking, rather than to fill their minds with masses of unrelated facts, which are always available, providing they have been taught where to find them. Convenient and accessible libraries should be built up, even at the expense of the laboratory, and students taught to use books constantly, as they would indispensable methods in the laboratory. Our graduate students for the most part have access to too much work and thought evading equipment. It is really surprising what can be done in the way of substantial research without costly apparatus. It is only necessary to refer back to the old masters of science to substantiate this statement.

Let us therefore stop deluding ourselves. The aim of research is not solely the accumulation of facts for immediate publication so that we may in vainglory point to our output for the year. We must strive to do more constructive thinking and especially give our minds an opportunity to function through proper relaxation. We shall not advance fundamental science if we are simply busy collecting data. With more constructive thinking on our problems there would be fewer but better publications, an era without doubt we should all sincerely welcome.—George L. Peltier, University of Nebraska

—*Science.*

. . . There are few men living who have a greater capacity for work and who are more tireless in their work than Charles F. Baker. He is a man who sees big visions and who, instead of dreaming, sets about with joyful zeal and a bulldog determination to make these visions realities. As a friend, one can want no better. As an enemy, one never is in doubt as to his opinions and sentiments. He is open-hearted and large-hearted. One feels a strong stimulus to a better and a larger life when he comes into contact with this man.—David L. Crawford, *Professor of Botany.*

—(*From Pomona College Journal of Economic Botany III:* Dec., 1914).

Dean——of Harvard has proposed a "battle of culture" to take place between student teams of ten men each from Yale and Harvard. Under the plan the teams would take identical examinations which would cover all departments of study. The object of the competition is to stimulate interest in studies to offset the emphasis now placed on athletics.

—*What The Colleges Are Doing.*

I like trees
Which do not fear to stand
All alone against the sky,
With space on either hand.

And I like the folk
Who need not herd together,
It takes the strongest trees and men
Alone to face the weather.

—Hilda Morris in *Rural New Yorker.*

—*The Aberden-Angus Journal.*

The creative scholarship of the teacher is what makes "higher education" higher than other education. It behooves universities to foster and conserve it, as it behooves students to appreciate it.

—*Harvard Alumni Bulletin.*

A man there was, at least he *looked* like *man;*
His hair was smooth, his coat, spick and span.
And yet in the place God made for a mind,
There was nothing at all! Fine fruit—but all rind!

—C. F. Baker.

THE TREND OF SEXUAL AND REPRODUCTIVE SEASONS AMONG HORSES, CATTLE, WATER BUFFALOES, SHEEP AND GOATS UNDER LOS BAÑOS CONDITIONS: A PRELIMINARY REPORT[1]

VALENTE VILLEGAS
Of the Department of Animal Husbandry

WITH TWO CHARTS

The animal breeder desires to know any tendency there may be in the seasonal activities of breeding animals under his care. A knowledge of the trend of females to come in heat and become fertilized during certain periods of the year would lead to a more rational preparation and distribution of the males during such seasons and a consequent higher reproductive efficiency of the females. Also, information concerning the production of a greater number of young during certain months of the year is advantageous as the breeder can provide adequate facilities so as to reduce the mortality to the minimum when reproduction occurs during unfavorable months of the year.

REVIEW OF LITERATURE

Gay (1923) states that the spring season is the natural time for foals to arrive but mares may be bred to foal during the fall.

According to Mumford (1920) the sexual functions of horses and cattle are more active in the spring. In the case of the mutton and merino sheep, the sexual activity is more prominent in the fall. The Dorset Horned breed of sheep may breed any time of the year.

Marshall (1922) points out that mares are polyoestrous, the sexual season occurring in spring and early summer, being the longest with more domesticated breeds. Citations are made by the same author that wild cattle show a restricted sexual season, while domesticated individuals breed any season of the year. With sheep some wild species are monoestrous while certain more domesticated breeds are polyoestrous. Reference is made to the hill sheep of Great Britain which usually breed from about the middle of November until the end of the year; in the other breeds the sexual season is earlier. The British sheep breed only once a year with the exception of the Limestone sheep of Westmoreland and Derbyshire and the Dorset Horn Sheep of the south of England which breed more than once a year. Certain Australian Merinos are claimed to exhibit sexual activity all the year round. With regard to the Indian sheep, there is no definite season

[1]Experiment Station contribution No. 579. Read before the Los Baños Biological Club on November 22, 1928. Received for publication November 26, 1928.

for lambing. Wild goats behave in a similar manner, according to Marshall, that is, their sexual season is restricted. Citing Low, in the case of domesticated goats, oestrum takes place at very frequent intervals.

Asdell (1926), studying the "Kid Register" of the British Goat Society, found that the maximum reproduction takes place in October and the minimum in May.

From a study of various breeding establishments of draft horses in the United States, Villegas (1923) found that many of the farms have an open breeding season from March till July, while a few of the establishments accept mares for breeding any month of the year.

OBJECT

The object of this report is to set forth observations on the trend of sexual and reproductive seasons among horses, cattle, water buffaloes, sheep and goats under Los Baños conditions.

TIME AND PLACE

The data presented are based mainly on the reproductive records of animals of the Department of Animal Husbandry with the exception of a few mating records of horses and goats.

Based on the reproductive records of the different classes of animals observed in this department the periods covered by this study are:

CLASS OF ANIMALS	INITIAL DATE OF REPRODUCTION	LAST DATE OF REPRODUCTION	PERIOD
Horses	Nov. 20, 1920	July 31, 1928	7 yrs., 8 mos., 11 da.
Cattle	April 22, 1920	July 7, 1928	8 yrs., 2 mos., 15 da.
Water buffaloes	Jan. 15, 1917	July 18, 1928	11 yrs., 6 mos., 3 da.
Sheep	Sept. 14, 1923	March 12, 1928	4 yrs., 5 mos., 27 da.
Goats	Jan. 18, 1923	April 14, 1928	5 yrs., 2 mos., 27 da.

ANIMALS

The greater number of the mares used in this investigation were of native breeding, a few of them being grades with Arabian blood. With cattle, the majority were natives and grades; there was a small number of pure individuals of the Nellore and Hereford breeds. The water buffaloes were mostly native carabaos with a small number of Indian buffalo breed and grades. The sheep were largely of Indian blood. In the case of goats, practically all of the animals were Indian and Nubian grades.

Few of the females studied were very old, most of them being very young or medium in age for breeding purposes.

MANAGEMENT

Horses belonging to the College of Agriculture were observed for oestrum and subsequently bred to the stallion. A general procedure was followed

with regularly breeding mares; they were bred at foal's heat, or nine days after foaling; in almost all cases the mares willingly received the male. With outside mares most of them were bred at random by stallions which by chance came in contact with the mares at the period of heat.

With cattle, water buffaloes and sheep, breeding took place in the pastures. At all times the requisite number of males was placed with the females to insure the breeding of all females that were in heat.

For a time the breeding of does was carried out by allowing the buck to go with the herd at all times. Later, when the condition of the male was observed to run down the system was changed. The buck was mixed with open does for a brief period each morning so that any of them that might be in oestrum were bred at that time. The buck was then returned to his pen where individual care and feeding was given to him. With this treatment the buck is expected to increase in breeding efficiency and longevity.

DISCUSSION OF RESULTS

The basic data from which the matings of each class of animals were computed consist mostly of the records of reproduction of the females. As has been mentioned, a few records of matings among horses and goats were directly used. Such records include data giving only one definite mating with a corresponding reproductive event for each female.

Where no matings are known, these were obtained by counting back the number of days corresponding to the average normal period of gestation of each class of animals from the dates of reproduction. For horses a period of 340 days was used; for cattle, 280 days; for water buffaloes, 324 days; and for sheep and goats, 150 days.

It, therefore, follows that the dates of matings here presented cover only successful services.

It is understood that the animals included in this study may be bred any time of the year when their period of oestrum comes. It seems, however, that with classes of animals showing a preponderance of sexual activities during certain seasons of the year, they strongly evince their desire for mating in those seasons and become more readily impregnated.

As previously stated, the reproductive records presented here are actual data pertaining to each female, from which the major part of mating records were obtained. It is evident, however, that the reproductive activities of the animals are determined by the season of successful matings among them.

The primary aim in presenting the reproductive incidence of the animals, is therefore, to present any definite behavior there may be in the reproductive season of each class of animals with a view of providing the necessary care for the young born during unfavorable months of the year.

Horses

As may be seen in table 1, there were 53 matings with mares, of which the greatest number occurred in March and April, constituting for the two months a total of 50 per cent of all the services during the year. The mares were also successfully bred in other months of the year but to a much lesser extent. For a more concise comparison of the percentages for each month see chart 1.

Despite the relatively small number of cases on which the results are based, it is apparent that the most suitable season to have mares bred is during the dry and hot months of March and April.

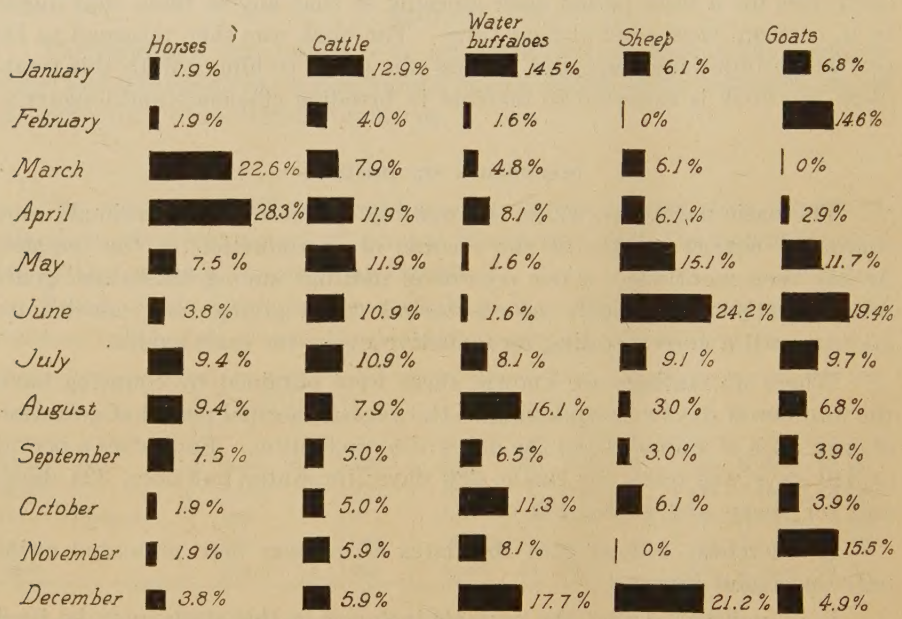

Chart 1.—Showing the monthly distribution of successful matings among horses, cattle, water buffaloes, sheep and goats.

As may be seen in table 1 and chart 1, out of the 53 foalings, 36.5 per cent fall during March. For the two months of February and March, the reproductive incidence amounts to almost one-half of the total, or 48 per cent. In April the percentage was 7.7, so that during the three months from February to April over half of the reproductive incidence took place, or 55.7 per cent. It is, therefore, evident that, even with only 53 foalings as a basis, the trend of the reproductive season is sufficiently marked that it may be said to center during the beginning of the dry season.

Cattle

Table 1 shows a total of 101 matings among cattle included in this study. From this table and in chart 1, it does not seem that cattle have the

tendency to breed in any given season of the year. The higher percentages shown from March to August over the rest of the months, except January, are not marked enough to indicate that such months constitute a more favorable sexual period for cattle. Less importance may be given to such months considering that the highest percentage during the year occurs in January, preceded and followed by lower percentages for December and February. The different percentages of sexual activities distributed for the months of the year may, therefore, be taken as the result of natural variations in the breeding behavior of cattle. Hence, it may be assumed that cattle mate any time of the year.

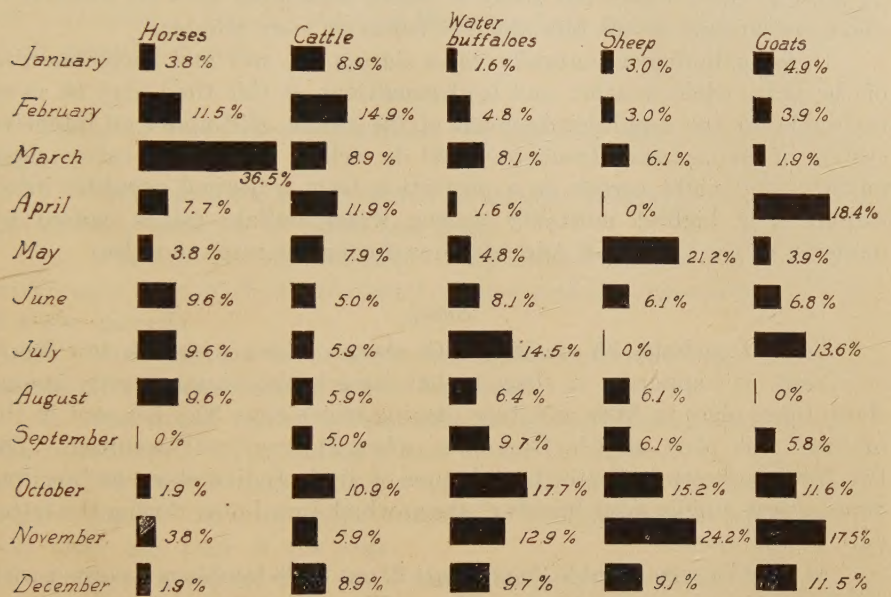

Chart 2.—Showing the monthly distribution of reproductive incidence among horses, cattle, water buffaloes, sheep, and goats.

Table 2 and chart 2 show that no marked season was followed in the reproductive period of cattle. The total number of calvings covered by the study was 103, of which the lowest percentage was 5, occurring in June and September, and the highest percentage 14.9, occurring in February. The variations in the calvings for the different months do not show any marked tendency to indicate the period of the year when these animals would naturally calve following successful breeding activities, although to a certain degree, chart 2 shows that during the early and later parts of the year the percentages are relatively higher than during the middle which are the wet months.

If this is true, it would be a fortunate coincidence because there will likely be fewer losses when calving occurs during the drier period of the year.

Water buffaloes

Sixty-two successful matings are shown in table 1 with water buffaloes. Looking over chart 1, it appears that the preponderance of sexual activities fall from August till January, or during the cooler and wet months of the year. However, on account of the relatively small number of matings upon which the results are obtained it does not seem justifiable to make conclusions. A greater number of cases should first be noted.

According to table 2 and chart 2, the greater calving season among water buffaloes is during the second half of the year. From July till December over 70 per cent of the calvings took place. There are, however, only 62 calvings upon which this study is based; additional data are awaited to make conclusions on the reproductive behavior more reliable.

If water buffaloes naturally calve during the wet and cooler months of the year, while weather and feed conditions at this time may be most favorable for the rapid development of the young, still under an intensive system of management breeders would do well to provide for calves clean pastures and night corrals as a protection from intestinal parasitic infestation. The highest mortality among water buffalo calves caused by parasites at the College of Agriculture is during the rainy months.

Sheep

Table 1 includes 33 matings with sheep. Even with this low figure as a basis, it is apparent on chart 1, that the greatest sexual activity among sheep takes place in May and June, during which time 39.3 per cent of the matings took place, and in December, when 21.2 per cent occurred. The two periods shown indicate the behavior of grade Indian sheep as breeding twice a year, unlike most breeds of sheep which breed only during the latter part of the year.

As may be seen in table 2 and chart 2, out of 33 lambings recorded with sheep, 21.2 per cent occurred in May. This was followed by the second lambing season which was in October and November, giving a total 39.4 per cent. For a more definite conclusion, however, more data are necessary.

Goats

Table 1 shows that with goats 103 matings are included in this study. Like sheep, goats exhibit two sexual seasons during the year. As may be seen in chart 1, it is evident that during May and June sexual activity is heavy, or a total of 31.1 per cent; the second period falls in November, with 15.5 per cent, probably covering the period until February, during which month the percentage is 14.6. The low figures for December and January are expected to show more favorably, later, as mating records increase.

There are also two marked kidding seasons with does, as shown in table 2 and chart 2. Out of 103 kiddings, the highest percentage 18.4

occurs in April. From April to July probably constitutes the first period, with a total of 42.7 per cent followed by the second period from October till December, with a total of 40.6 per cent. The fact that August does not show any kidding deserves mention, considering that there are more than 100 cases treated in this study.

Undoubtedly with goats as with sheep, there exists two marked reproductive seasons in the year. The first season starting in April produced kids facing a rather unfavorable climatic condition during the rainy months of the year. In the second season which begins in October, when it is wet and cool, the kids, if properly taken care of while young, may fare better than those born the previous season, because of the drier months which follow October. This dry season is the time of the year during which goats of all ages thrive best.

SUMMARY

From the foregoing observations the following salient points may be noted:

1. Sufficient data are presented to indicate definitely the sexual and reproductive behavior of cattle and goats.
2. While the records available for horses and sheep are not large, the percentages show markedly the trend of the sexual and reproductive seasons of these animals.
3. More data are necessary to indicate the real trend of the sexual and reproductive seasons among water buffaloes.
4. The sexual season with horses takes place during the months of March and April. The foaling season occurs in March.
5. With cattle the sexual and reproductive seasons do not follow any decided trend. An appreciable number of matings and calving incidents take place any time of the year.
6. It is apparent that with water buffaloes the trend of both the sexual and reproductive seasons appears to be heavier during the second half of the year.
7. Sheep breed mostly in May and June and again in December. The lambing time takes place heavily in May and even more abundantly in October and November.
8. Goats follow practically the same sexual and reproductive seasons as sheep. May and June recorded high in sexual activities, the next season occurring from November till February. The kidding season starts in April and covers a period of four months or until July; it begins again in October and ends in December.

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TABLE 1

ving the monthly distribution of successful matings among horses, cattle, water buffaloes, sheep, and goats

MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
number	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*
12	22.6	15	28.3	4	7.5	2	3.8	5	9.4	5	9.4	4	7.5	1	1.9	1	1.9	2	3.8
8	7.9	12	11.9	12	11.9	11	10.9	11	10.9	8	7.9	5	5	5	5	6	5.9	6	5.9
8	11.0	6	8.2	10	13.7	9	12.3	6	8.2	4	5.4	5	6.9	3	4.1	4	5.5	4	5.5
0	0	5	29.4	1	5.9	2	11.8	2	11.8	2	11.8	0	0	2	11.8	1	5.9	0	0
0	0	1	9.1	1	9.1	0	0	3	27.3	2	18.2	0	0	0	0	1	9.1	2	18.2
3	4.8	5	8.1	1	1.6	1	1.6	5	8.1	10	16.1	4	6.5	7	11.3	5	8.1	11	17.7
3	6.5	3	6.5	1	2.2	1	2.2	5	10.9	7	15.2	4	8.7	4	8.7	3	6.5	9	19.6
0	0	2	12.5	0	0	0	0	0	0	3	18.8	0	0	3	18.8	2	12.5	2	12.5
2	6.1	2	6.1	5	15.1	8	24.2	3	9.1	1	3.0	1	3.0	2	6.1	0	0	7	21.2
0	0	3	2.9	12	11.7	20	19.4	10	9.7	7	6.8	4	3.9	4	3.9	16	15.5	5	4.9

TABLE 2

ving the monthly distribution of reproductive incidence among horses, cattle, water buffaloes, sheep, and goats

MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
number	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*
19	36.5	4	7.7	2	3.8	5	9.6	5	9.6	5	9.6	0	0	1	1.9	2	3.8	1	1.9
9	8.9	12	11.9	8	7.9	5	5.0	6	5.9	6	5.9	5	5.0	11	10.9	6	5.9	9	8.9
8	11.0	6	8.2	6	8.2	3	4.1	5	6.8	3	4.1	5	6.8	8	11.0	6	8.2	7	9.6
1	5.9	3	17.7	1	5.9	1	5.9	1	5.9	2	11.8	0	0	1	5.9	0	0	1	5.9
0	0	3	27.3	1	9.1	1	9.1	0	0	1	9.1	0	0	2	18.2	0	0	1	9.1
5	8.1	1	1.6	3	4.8	5	8.1	9	14.5	4	6.4	6	9.7	11	17.7	8	12.9	6	9.7
3	6.5	1	2.2	3	6.5	5	10.9	6	13.0	4	8.7	3	6.5	8	17.4	6	13.0	3	6.5
2	12.5	0	0	0	0	0	0	3	18.8	0	0	3	18.8	3	18.8	2	12.5	3	18.8
2	6.1	0	0	7	21.2	2	6.1	0	0	2	6.1	2	6.1	5	15.2	8	24.2	3	9.1
2	1.9	19	18.4	4	3.9	7	6.8	14	13.6	0	0	6	5.8	12	11.6	18	17.5	12	11.5

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CLASS OF ANIMALS	JANUARY		FEBRUARY	
	number	*per cent*	*number*	*per ce*
Horses	1	1.9	1	1.9
Cattle:	13	12.9	4	4
Natives and grades	11	15.1	3	4.1
Nellores	1	5.9	1	5.9
Herefords	1	9.1	0	0
Water buffaloes:	9	14.5	1	1.6
Carabaos	5	10.9	1	2.2
Indian buffaloes	4	25.0	0	0
Sheep	2	6.1	0	0
Goats	7	6.8	15	14.6

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CLASS OF ANIMALS	JANUARY		FEBRUARY	
	number	*per cent*	*number*	*per cen*
Horses	2	3.8	6	11.5
Cattle:	9	8.9	15	14.9
Natives and grades	4	5.5	12	16.4
Nellores	4	23.5	2	11.8
Herefords	1	9.1	1	9.1
Water buffaloes:	1	1.6	3	4.8
Carabaos	1	2.2	3	6.5
Indian buffaloes	0	0	0	0
Sheep	1	3.0	1	3.0
Goats	5	4.9	4	3.9

COMPARATIVE WEAR OF CERTAIN METALS AND ALLOYS USED IN PLOWS AND DISK HARROWS[1]

ALEJANDRO B. CATAMBAY
Of the Department of Agronomy

FIVE TEXT FIGURES

Of all tillage implements the plow and harrow are probably in most common use for crop production. Their importance is so great that investigators have spent much time in trying to attain a satisfactory design to meet varying field conditions. These two implements have been studied so intensively by plow and harrow designers that there are many models on the market.

The study here reported was made on the University of California farm at Davis, California, from August 1926 to May 1927.

NATURE OF THE PROBLEM

The quality of work accomplished in plowing depends largely upon the shape of the bottom of the plow. A satisfactory model for certain field conditions can be obtained; the problem is to maintain the shape of the bottom as long as possible. The way to accomplish this is to choose material that will withstand the wear caused by the erosive action of the soil.

Maintaining suction of plowshares. It is a well known fact that vertical and horizontal suctions of the plow bottom are important to secure good and even penetration. Ramsower (1917) defines vertical suction as the force that draws the plow into the ground; it is secured by dipping the point of the share downward below the bottom line of the landside. Horizontal suction is the force that helps keep the plow bottom to the land (unplowed portion of the field) thereby maintaining an even cut. As the shares dull through wear, these suctions are weakened and the power of penetration is lessened. If the share is made of steel the point may be bent downward to secure vertical suction but not if it is made of chilled cast iron. But the bolts of a chilled cast iron share can be loosened and by inserting shims of tin or leather behind the bolts, the vertical suction may, in a measure, be restored. The hitch adjustment does not change the suction, which may help secure penetration.

Scouring by moldboards and shares. The moldboard is the part adjacent to the share. It is the function of the moldboard to turn over the

[1] Experiment Station contribution No. 580. A part of a thesis presented in the University of California for the degree of Master of Science in Agricultural Engineering. Received for publication, September 28, 1928.

furrow slice evenly after it has been cut by the share. When operating properly, a clean polished surface is maintained on both share and moldboard. This is called scouring. Failure to scour which means a greater draft and hence the need of more power, can be attributed to many causes but chiefly to soft spots, inequalities, and depressions in both share and moldboard, and to soil condition. A moldboard may be smooth and well polished yet after some hours of use it may fail to scour. For this condition, Bacon (1918) found that silicon, one of the soil components is mainly responsible. It scratches the surface of the metal leaving tiny grooves to which the clay sticks. This trouble may be prevented by using material for both share and moldboard hard enough to withstand this erosion of silicon. It has been found that chilled cast iron is sufficiently hard but it is impossible to manufacture free from depression shares and moldboards of this material; a condition that is secured when steel is used.

Disk penetration. The principles involved in the action of the disk harrow and disk plow are practically the same except that the disk plow is subject to a more severe test. The blades of both are usually of the same material. Ramsower (1917) found that the following factors influence the penetration of a disk harrow:

1. Angle of disks.
2. The weight of the harrow.
3. The sharpness of the disk.
4. Size of disks.
5. The dish of the disks.
6. The angle of hitch.

Of these factors the first three are the most important. The angle of disks which means the angle which the two gangs or sets of disks makes with each other can be directly adjusted by the operator. Weight can be put on the harrow if so desired. The sharpness of the disks and the subsequent maintaining of their size can be partly controlled by the materials from which they are made. The majority of farmers use their disks dull; few grind them. This means poor economy since the work is less satisfactory owing to lessened penetration.

IMPORTANCE OF THE PROBLEM

In the study of the possibility of introducing modern farm machinery into the Philippines for rice production, the writer became acquainted with the soil conditions in the rice growing regions of California. The soil is of dark gray to black clay. Jones (1923) found that because of the adobe structure of the soil, it is almost impossible to till it. The soil is sticky when wet, hard and full of cracks when dry. Because of these characteristics, it wears plow bottoms and harrow disks to a considerable degree as compared with ordinary soil conditions.

In the same study the writer found that it is almost impossible to introduce into the Philippines the large pieces of machinery because of the size of the individual farm, the unfamiliarity of the people with the machines, and the topography of the land in the irrigated districts which causes the construction of small checks. It may be possible that reduction of the present power requirements could be partly and directly effected by making specially designed plow bottoms out of the proper metal or alloy.

In the upland, or dry farming, lies the possibility of increasing the rice acreage in the Philippines. As the name suggests, in the upland rice growing the soil is worked dry, this subjects tillage implements to severe tests. The most common plow used is the moldboard type and when the soil is worked dry, dull shares and lost suction are very common. Furthermore, the upland rice farms are generally remote from towns where repair shops can be found. For these reasons, the putting out of specially made shares and moldboards that will resist excessive wear would save the farmers the trouble and expense of frequent repairing and, in a measure, would lower their power requirements. The same conditions apply to sugar cane growers.

MATERIALS AND MACHINERY

The disks and shares under test in this study obtained in the College of Agriculture of the University of California were from various companies selling farm machinery.

As a source of power, different tractors were used. Many of these tractors were loaned to the college by the manufacturers.

Disks

The harrow disks were of five groups marked 2 to 6 inclusive. The disks marked No. 6 were the regular disks now on the market. These are made of high carbon steel not heat treated. Nos. 2, 3, 4 and 5 are made of special steel and had been given various heat treatments. Disks marked No. 2 are the hardest of the lot, No. 3 are slightly softer and No. 4, still softer. No. 5 disks are softer than No. 4 but are considerably harder than No. 6.

The group marked No. 2 are disks which have been oil quenched but not drawn and the Brinell hardness on this material is about 444. Group No. 3 represent the same material as No. 2 with the same heat treatment plus a draw back in the furnace to a Brinell hardness of about 418. Group No. 4 represents disks from a different heat treatment; these contain slightly high carbon, but were bought to the same specification. These disks were oil quenched and then drawn back to a Brinell hardness of 418. Group No. 5 represents disks of the same specification material but drawn back further to a Brinell hardness of 387. Group No. 6 which are the regular disks marketed by one company have a Brinell hardness of approximately 207 to 235.

Shares

The shares under test were the chromium plated soft center steel and Krupp steel. Shares of ordinary chilled cast iron and soft center steel were used as reference shares to determine the relative amount of wear. In a previous series of tests conducted by the Division of Agricultural Engineering, University of California, manganese steel shares of different heat treatment were tested using also the ordinary soft center steel and chilled cast iron as reference. Data on these tests are given in table 3.

Chilled cast iron. Johnson (1919) describes chilled cast iron as follows:

Cast iron consists of metallic iron together with at least 1.5 per cent of carbon. It also contains silicon, sulphur, phosphorous, manganese, and other elements in greater or less proportion, but these may be regarded as impurities, though their presence is often useful or even necessary for the purposes for which cast iron is applied. Cast iron is fusible at a

Fig. 1.—Upper surface of the chromium plated soft-center steel share. At the middle will be noted the portion with cooper-nickel plating without the chrome. The rest of the share was chrome plated.

temperature of about 2200° F. (1203.24° C.); when cold it is brittle and hard, some varieties being much more so than the others. Chills are used when it is desired to produce a casting the outside of which is unusually hard. The iron is generally a close grained gray, and this converted into white iron where it comes in contact with the cold side of the mould during solidification.

Soft center steel. Rynders (1920) gives the description of soft center steel share and its manufacture as follows:

Soft center steel is a laminated structure of three separate layers of steel. The outer layers are of high carbon or eutectoid steel, while the center layer is of a low carbon or hypo-eutectoid steel. In addition to these layers, it is the common practice to weld an extra high carbon steel pad on the greatest wearing surface of the share and moldboard thus giving a complicated structure of hypo-eutectoid, eutectoid, and hyper-eutectoid steels. The hardening temperature ranges of the three steels are about as follows: Hypo-eutectoid 1600°–1650° F. (860.24–898° C.); eutectoid, 1400°–1500° F. (759.24–814.74° C.); hyper-

eutectoid, 1350°–1400° F. (731.49–759.24° C.); allowance being made for 60° drop in temperature after removing from the furnace. The hypo-eutectoid layer is a low carbon steel, soft, tough and flexible; qualities which must be retained throughout the hardening process. It strengthens the outer layers to withstand the impact against stones in plowing the field.

Chromium plated soft center steel. In a letter to the writer, A. L. Collins, Electroplating expert, Berkeley, California, described the process of plating as follows:

The entire share was placed in a nickle bath for twenty minutes, and a copper bath for twenty minutes; then over the point was plated the chrome in a one-hour bath. The middle section was untouched and shows the final copper plating. The remaining section (the rear portion of the share) has chrome plate directly on the steel. The nickle and copper were buffed off before this operation. (See fig. 1 and 2.)

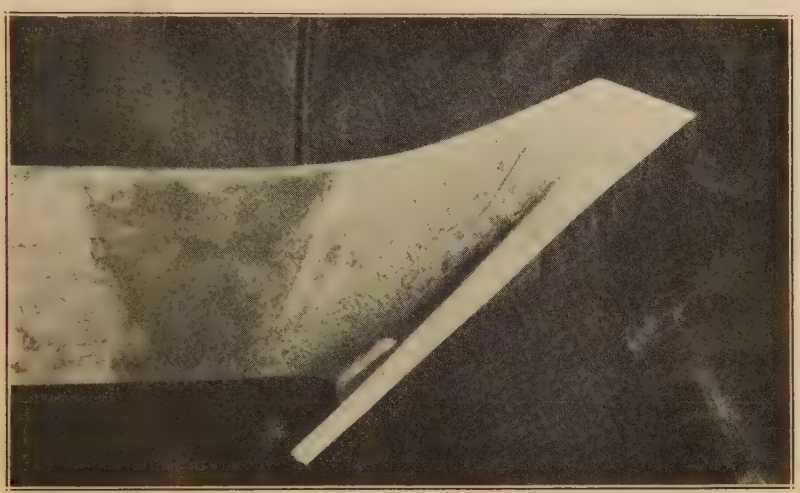

Fig. 2.—Bottom surface of the share of fig. 1.

Krupp steel. In a pamphlet, "Forged Plowshares" Friedrich Krupp describes this material thus:

This (the krupp steel) is a special brand of steel remarkable for its hardness and toughness. The shares of this material can be redrawn as the material is uniform throughout. For redrawing, the share should be heated to a temperature of about 950° to 1000° C. For hardening, the point edge should be reheated to about 780° to 800° C. and then immersed in hot water.

METHODS OF TESTING

Harrow disks

The disks were marked with center punch and then weighed four times on a scale reading to 0.01 pound (.0045 kgm.) taking the average as the representative weight. Then each disk, before using, was traced with the flat side down to determine the exact size. This tracing was later used to determine the amount of wear of each disk after subjecting them to use.

The disks were then attached to a single 12 disk John Deere harrow (see fig. 3 and 4).

The disks were then subjected to road work for fourteen hours, with the Fordson tractor for the first eight hours and the Samson for the last six hours. The road was sandy and gravelly thus giving the disks a good wearing test. The test lasted for 20 hours covering an approximate distance of 35 miles (57.315 km.).

Each disk was reweighed and retraced after the test, using the original tracing paper, one side coinciding with the same side of the first tracing, thus forming eccentric circles. By this method, the wear on one diameter is measured on one side of the tracing.

Fig. 3.—A 12-disk John Deere harrow was used in the wearing test. The road is rough and newly gravelled. A Fordson and a Samson Model M were used.

Plowshares

The shares were marked at the rear using an emery wheel because of their hardness. Each share was weighed four times carefully, taking the average as the representative weight. Each was traced in two positions to show both vertical and horizontal suctions. The traced edges are generally the parts that received the greatest wear. After using the shares they were reweighed and retraced on the same tracing paper to determine the relative amount of wear.

The plow used for the test was a John Deere 3-12 inch bottom gang plow. The share under test was placed on the middle bottom with the front and rear shares of the reference material. For comparison of wear, the average wear of the front and rear shares was used.

Field and soil condition

In the plowshare tests two different fields were used. In the first test the field was so weedy that it was necessary to disk it first. The soil was

wet because of frequent rains previous to the test. These field conditions made the use of rolling coulters necessary (see fig. 5).

In the second test the field used was an old alfalfa sod which had been trampled by cattle. It was somewhat dry and the tramping of the animals had made the soil compact and hard. In both fields the soil is of the Yolo fine sandy loam, rather black and heavy.

DISCUSSION OF RESULTS

Harrow disks

Table 1 gives the data of the tests on the disks. The table includes weights before and after tests, average loss of weight of each group and their respective Brinell hardness number.

Fig. 4.—Weights were placed on both sides of the harrow to secure good penetration. They were approximately the same. During the whole test the gangs were set at full angle.

It may be observed that the average loss of weights of each group increases with the decrease of the Brinell hardness, excepting with No. 3 and No. 4. These disks have the same Brinell hardness but No. 4 shows slightly greater wear. According to the manufacturer's statement they are of different heat treatment and group No. 4 has a slightly higher carbon content.

Group No. 6 which are the usual disks on the market show the greatest amount of wear. The edges became dull more rapidly and were made irregular by being stressed beyond the elastic limit. Judging by the Brinell hardness, group No. 2 is about twice as hard as group No. 6 (Brinell hardness, 444: 207 to 235) yet there was no sign of breakage in any of the disks of group No. 2. The sharpness of disks, which is very desirable to obtain good penetration seems to be about four times as good in No. 2 as in No. 6.

Plowshares

The results on plowshare tests are grouped together in tables 2 and 3. Table 2 shows the tests on two shares made of chromium plated soft-center and krupp steels.

In the first test the wear of the chromium plated share placed on the middle bottom of the plow is slightly less than the average wear of the rear and front, the shares of the reference material (soft-center steel). However, after twelve hours of use it was found that the plating was entirely worn off and hence any further use would give only about the same wear as the reference shares. The slight difference can be attributed to the plating.

From the same table, it can be seen that the amount of wear on both reference shares in the first test was very much less than that of the reference

Fig. 5.—This field is an old alfalfa sod and previously trampled by cattle. The soil was compact, somewhat dry and very hard. Because of this condition a 30 H.P. Caterpillar tractor was used to pull the 3 bottom John Deere gang plow.

shares in the second test although the hours of use in the first test were twice that in the second. This unexpected difference was because of the moisture content of the soil and previous treatments of the fields.

Table 3 includes five series of tests marked A, B, C, D, and E.

In series A, the shares used were the soft-center steel, chilled cast iron, and manganese steel. The positions of each of these shares were interchanged after each third of a test was completed. Series B was a repetition of A, using duplicate shares. From these two tests the wear on the chilled cast iron share was the least, slightly more on soft-center steel, and most on manganese steel.

Series C was a test on the Hercules heat treated share placed on the middle bottom between two chilled cast iron shares. The wear was found to be more on the special steel and least on the chilled cast iron.

Series D was a test in a set of three manganese steel shares with different heat treatment. The differences in wear were very slight and it was due in part to the positions of the shares, that is least wear on front share and slightly more on rear.

Series E was of the same set of shares used in series D, that is, cold hammered to restore vertical suction. To compare their relative wear, this test was run without interchanging the positions of the shares. It was confirmed that the wear in front is the least and in the rear the most.

SUMMARY AND CONCLUSIONS

1. The usual disks on the market at present are rather soft and can be improved by hardening.

2. Although disk group No. 2 is about twice as hard as No. 6, as indicated by their respective Brinell hardness, there was no sign of breakage in any one of them. This condition was also true with the other groups. Because of these properties of group No. 2, it would be to the advantage of the farmers if disks under this group were put on the market.

3. Chilled cast iron shares show a slightly less wear than the soft-center steel shares.

4. Manganese steel which was thought to be hard enough for shares was found to wear out faster than either the soft-center steel or the chilled cast iron.

5. The chromium plating on the soft-center steel shares was soon worn off.

6. Krupp steel share showed slightly less wear than the soft-center steel.

7. Soft-center steel share maintained a higher polished surface than the krupp steel.

8. The wear of plow bottoms is likely to be different in front and rear.

9. The parts of the share that receive the greatest wear are the point, edge, and just beneath the point; wear in the point destroys the vertical suction.

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TABLE 1

Wear of harrow disks

GROUP NO.	WEIGHT BEFORE TEST	WEIGHT AFTER TEST	LOSS OF WEIGHT	AVERAGE LOSS OF WEIGHT	BRINELL HARDNESS	REMARKS
	kgm.	*kgm.*	*kgm.*	*kgm.*		
2	3.150	3.141	0.090	———	444	
2	3.155	3.150	.005	———	444	
2	3.168	3.164	.004	0.006	144	
3	3.073	3.064	.009	———	418	No. 3 and 4 have same
3	3.014	3.005	.009	0.009	418	Brinell hardness but
4	2.991	2.973	.018	———	418	No. 4 has a slightly
4	3.132	3.118	.014	0.016	418	higher carbon content.
5	3.050	3.036	.014	———	387	
	2.909	2.886	.023	———	387	
5	3.032	3.009	.023	0.020	387	
6	3.041	3.014	.027	———	207–235	
6	3.114	3.082	.032	0.029	207–235	Ordinary disks.

NOTE: The work was done on a rough, newly gravelled road. Tractors used were a Fordson and a Samson Model M. The average speed was about 2.5 miles (4.023 km.) per hour; the hours used, 14; distance covered, 35 miles (57.315 km.). Each weight of disk as here given is the average of four weighings.

TABLE 2

Wear of plowshares

MATERIAL STEEL	WEIGHT BEFORE TEST	WEIGHT AFTER TEST	LOSS OF WEIGHT	TEST SERIES	HOURS USED	SOILS	REMARKS
	kgm.	*kgm.*	*kgm.*				
Soft-center	4.736	4.727	0.009	1st	12	Moist fine sandy loam	Front
Chromium plated soft-center	4.859	4.850	0.009	1st	12	" "	Middle
Soft-center	4.755	4.726	0.029	1st	12	" "	Rear
Soft-center	4.968	4.909	0.059	2nd	6	Hard puddled sandy loam	Front
Krupp	5.086	5.041	0.045	2nd	6	" "	Middle
Soft-center	4.863	4.791	0.072	2nd	6	" "	Rear

NOTE: The tractors used were a Cletrac, 2–Ton Caterpillar, and a 30 H.P. Caterpillar. The average plowing speed was about 2.4 miles (3.862 km.) per hour.

TABLE 3

Wearing test of plowshares; tractor speed about 2.8 miles (4.505 km.) per hour

MATERIAL	ORIGINAL WEIGHTS	LOSS OF WEIGHT	HOURS USED	SOILS	TEST SERIES	REMARKS
	kgm.	*kgm.*				
Manganese steel.....	4.068	0.377	106	Sandy loam	A	Shares interchanged as to position after each approximate one-third of useful life.
Chilled iron.....	5.126	0.250	106	"	A	
Soft-center steel.....	4.950	0.205	106	"	A	
Manganese steel T. W. I. and S. Co...	4.105	0.155	13.5	Dry sandy loam	B	Position on gang plow front share.
Chilled iron.....	4.959	0.050	13.5	"	B	Position on gang plow middle share.
Soft center steel.....	4.695	0.100	13.5	"	B	Position on gang plow rear share.
Chilled iron.....	4.900	0.141	28	Alf. sod. syd. loam	C	Position on gang plow-front share.
Special steel.....	4.377	0.204	28	"	C	Position on gang plow-middle share.
Chilled iron.....	5.023	0.177	28	"	C	Position on gang plow rear share.
Manganese steel Am. M. S. Co.	4.441	0.155	29.5	"	D	Position on gang plow front share.
Manganese A. M. M. S. Co.	4.818	0.205	29.5	"	D	Position on plow middle share.
Manganese Am. M. S. Co.	5.059	0.214	29.5	"	D	Position on plow rear share.
Manganese steel Am. M. S. Co.	4.741	0.041	12	Sandy loam	E	Front share. Vertical suction restored by cold hammering.
Manganese steel Am. M. S. Co.	4.609	0.23	12	"	E	Middle share. Vertical suction restored by cold hammering.
Manganese steel Am. M. S. Co.	4.282	0.036	12	"	E	Rear share. Vertical suction restored by cold hammering.

A STUDY OF CERTAIN CHEMICAL TREATMENTS IN RELATION TO SEED-BORNE DISEASES OF CALAUAN YELLOW FLINT MAIZE[1]

VALERIANO C. CALMA, LORENZO G. PADERNA AND MACARIO A. PALO

Corn (*Zea mays* L.) is the second important crop in the Philippine Islands. In some provinces it constitutes the principal food of the people. In 1925 there were 552,380 hectares of land planted to corn in the Philippines and the crop was worth ₱30,767,250[2]. No survey of crop losses caused by the ravages of diseases has been made, but Baker (1917) and Reinking (1918) estimated them at about 10 per cent annually, which would mean a yearly loss of a few million pesos.

Seed-borne diseases are an important source of loss in growing corn. They either kill the seedlings or so weaken the plants that they easily succumb to the attack of other diseases. Weakened plants generally produce diseased ears which form sources of inocula for the neighboring plants and for the following crop.

The most practical method of controlling seed-borne disease is by careful seed selection while the corn is in the field. Holbert and Hoffer (1920) recommend that only matured ears of at least medium size from upright, sturdy stalks, or plants whose stalks and portions of the leaves are still green and whose ears are supported at a convenient height on strong and sound shanks should be selected for seed purposes. Ears that are sound may be singled out from among the diseased ones by the bright rich luster, plump, clean kernels, with well-developed germs, shallow and smooth indentation and decidedly horny endosperm. The shank attachment should be clean and free from any discoloration.

The study of the merits of poisonous compounds bearing certain trade names was made by treating the kernels of Calauan Yellow Flint maize harvested in the native way with the dust and solution of these substances. The soundest looking kernels of this corn often have incipient infections of seed-borne diseases. The work was conducted from October, 1924 to January, 1926 and from October, 1926 to February, 1928.

[1] Based on two theses presented for graduation with degree of Bachelor of Agriculture from the College of Agriculture by Valeriano C. Calma in 1926, and Lorenzo G. Paderna in 1928. This paper was written by Mr. Macario A. Palo. Theses and paper were prepared in Department of Plant Pathology under direction of Dr. G. O. Ocfemia.

Experiment Station contribution No. 581; theses Nos. 278 and 279. Received for publication August 11, 1928.

[2] One peso (₱1.00) = $0.50 U. S. currency.

REVIEW OF LITERATURE

Bolley (1897) states that stinking smut of wheat is controlled by immersing the grains in 1 to 1½: 1000 solution of bichloride of mercury and that oats soaked for two hours in 2½: 1000 formalin solution gave a higher percentage of germination and a greater yield than the untreated seeds.

Braun (1920) states that copper sulfate solution is ineffective and detrimental to germinating seeds.

Leukel, Dickson, and Johnson (1926) used 1.0, 0.5 and 0.25 per cent of aqueous solutions of Uspulun, Semesan, Germisan and Corona and found after seven years of extensive experiments that Germisan gave the best results, Uspulun the next best and Semesan the poorest.

Reddy, Holbert, and Erwin (1927) soaked Diplodia-infected corn kernels in 0.4 per cent solutions of Semesan and Uspulun and 0.25 per cent Corona 620 solution and found that Uspulun-soaked kernels gave the best field stand, Semesan-soaked the second best, Corona 620-soaked the third, and the controls, the poorest. These investigators found also that the kernels soaked in Uspulun gave higher yields than those soaked in Semesan and Corona 620.

Reddy and Holbert (1928) report that *Diplodia* seedling-blight of sweet corn can be controlled by dust or liquid treatment of the seed with any of the compounds including Semesan, Uspulun, Corona 640, Bayer dust and many others that they tested.

Holbert, Reddy, and Koehler (1928) found in their experiments on the chemical-dust seed treatments for dent corn that varieties differ in the degree to which they are benefited by those treatments and that they are not always followed by an increase in yield. These authors used Bayer dust, Improved Semesan Jr., and Merko.

MATERIALS AND METHODS

Seed

Ears of Calauan Yellow Flint maize were obtained from the Department of Agronomy. The kernels two centimeters from the butt and five centimeters from the tip of the ears were discarded so that only large and fairly uniform kernels were used.

Chemicals

Copper sulfate, sulfur powder, formaldehyde, Derris powder, mercuric chloride and organic mercury compounds known under the trade names of Germisan[3], Uspulun[4], Semesan[5], Corona 640[6], Corona 640-S[7], and Colloidal copper[8] were used.

[3] Obtained from Saccharin-Fabrik in Germany.

[4] Obtained from Bayer Company of New York.

[5] Obtained from E. I. Du Pont de Nemours Co., Inc., Wilmington, Delaware.

[6], [7], [8] Obtained from Pittsburgh Plate Glass Company, Corona Chemical Division, Milwaukee, Wisconsin.

Formalin and mercuric chloride were used in the form of solutions which were prepared in concentrations of 0.1 per cent and 0.2 per cent. Germisan, Semesan, Uspulun, Colloidal copper, copper sulfate, Corona 640, and Corona 640-S were prepared in concentrations of 0.25 per cent, 0.50 per cent, 0.75 per cent and 1.0 per cent. Germisan, Uspulun, Corona 640, and Corona 640-S were used also in the form of dust with Bayer's Dipdust and Special dust and powder of *Derris elliptica*, *Derris polyantha*, and *Derris philippinensis*.

Determination of the seed-borne flora of Yellow Flint maize and the tissues wherein the organisms are carried

The seed-borne flora of the maize was determined by plating out the entire kernels of corn, kernels without seed coat, endosperms alone, and embryos alone on potato-dextrose agar, agar in water, and nutrient agar in petri dishes. The results obtained are summarized in table 1.

TABLE 1

The fungous flora of Calauan Yellow Flint maize

ORGANISMS OBTAINED[a]	PERCENTAGE INFECTION OF PARTS PLATED OUT ON POTATO-DEXTROSE AGAR, WATER AGAR, AND NUTRIENT AGAR.			
	Entire kernels	Kernels without seed coat	Endosperm alone	Embryo alone
Fusarium	100	80	80	70
Black mold	100	70	70	70
Yellow mold	40	20	10	30
Blue mold	20	10	20	10

[a] No effort was made to determine the identity of the *Fusarium* and molds obtained.

It may be seen in table 1 that *Fusarium* sp. and black mold are the predominating fungous flora in the seeds of Calauan Yellow Flint maize.

Tests of the efficiency of the chemicals used

The corn kernels were immersed in the solutions of Germisan, Uspulun, Semesan, Formalin, mercuric chloride, copper sulfate, Corona 640, Corona 640-S and Colloidal copper in test tubes for varying lengths of time covering the kernels to a depth of at least one centimeter. Every treatment had a control in which the kernels were soaked for the same length of time in sterile water. After the treatment, the corn kernels, including those in the checks, were spread on large filter papers to air-dry. Then the kernels were planted in sterilized soil in boxes. The plants were observed daily to determine the date of emergence, the percentage of germination, and condition of seedlings.

In the dust treatments the kernels were moistened with sterile water and then rolled until they were thoroughly covered with the fine powder of Germisan, Uspulun, Semesan, Dipdust, Special dust, Corona 640, Corona 640-S, powder of *Derris elliptica, Derris polyantha* and *Derris philippinensis*. The kernels used as control were moistened with sterile water as described by Leukel, Dickson, and Johnson (1926).

To determine the effect of the treatment on the production of ears, tests were conducted in the field. Only the concentrations and the lengths of immersion from the laboratory tests which indicated beneficial effects upon the seedlings and effectiveness in the control of seed-borne organisms were used.

The solutions used in field tests and their concentrations and lengths of immersion are given in table 2.

The dusts were not used in field tests because the seedlings from the treated kernels were the same as those of the control, and in some instances the treated seeds were poorer than those of the control. This result is in accord with the experience of Leukel, Dickson, and Johnson (1926) but contrary to that of Reddy and Holbert (1928) who reported that dust seed treatments for the control of *Diplodia* seedling blight of sweet corn are as beneficial as the liquid treatments and have the additional advantage of being more easily applied and involving less injury to the seed.

RESULTS

Laboratory experiments

In the laboratory experiments, soil sterilized with heat and placed in seed boxes was used. Previous to the tests with the chemicals, experiments carried on to determine whether or not soil sterilization has deleterious effects upon corn seedlings showed that it produces beneficial effects.

The criteria used for measuring the effects upon the corn of the various treatments in laboratory tests were: (1) height of the seedlings from fixed points on the surface of the soil to the tips of the longest leaf; (2) size of the shoots; (3) extent of the root systems; and (4) color of the vegetative parts as compared with those from untreated kernels.

Of the different chemical solutions used in the laboratory experiments, Germisan gave the best stand of seedlings. It was followed in success by formalin, next by Uspulun, then by Semesan. Mercuric chloride solution gave the poorest result.

Field experiments

Wet and dry season plantings were carried on in the experimental plot of the Department of Plant Pathology. The chemical solutions which showed controlling effects of seed-borne organisms and produced stimulatory effects upon the seedlings, and the lengths of immersion in these solutions

which gave the best results in the laboratory tests were tried out in the field.

Unfortunately, the soil of the plot that was assigned to the field trials was very poor because it had been planted to sugar cane, rice, tobacco, and corn repeatedly. The land was thoroughly prepared and furrows run 75 centimeters apart. During the wet season only one corn kernel was planted in each of the hills which were 70 centimeters apart in the furrows. In the dry season planting two kernels were planted in hills which were 75 centimeters apart. In both wet-and dry-season trials the treated corn kernels and the checks were planted in alternate furrows. The percentage of emergence in the wet-and dry-season tests did not agree with the percentage of germination in the laboratory tests. It was found that in the wet season plantings there was a higher percentage of emergence than in the dry season plantings.

When the plants were about 30 centimeters tall, leaf spots caused by *Ophiobolus heterostrophus* Drechsler and leaf blight caused by *Helminthosporium inconspicuum* Ell. and Evht. were present on the leaves of the plants. There were more leaf diseases in the wet season crop than in the dry season planting.

The tasseling of the corn of the wet-and dry-season plantings was not affected by the treatments. Both the control and the plants from treated kernels tasseled at about the same time.

The number and weight of the ears from each row and the number of diseased ears and nubbins were noted. The results are given in table 2.

The results obtained from the wet and dry season plantings of treated kernels may be summarized as follows:

1. None of the treated kernels in the wet and dry season plantings in the field gave 100 per cent germination. In some cases there were control kernels that gave a higher percentage of emergence than the treated kernels.
2. The wet season planting gave higher percentages of germination than the dry season planting.
3. All plants from treated kernels gave higher yields of ears than those of the control kernels.
4. The wet season planting produced more and larger ears than the dry season planting.
5. There were more diseased ears in the wet season planting than in the dry season crop.

As shown in table 2 the treatment that gave the highest yield with the use of formalin, mercuric chloride, Semesan, and Uspulun in the wet season planting did not give correspondingly the highest yield in the dry season planting. The kernels that were soaked in 0.25 per cent solution of Germisan for 8½ hours, however, gave the best yield in both wet and dry season plantings. By close inspection of the data in table 2 it may be seen that the formalin treatments that may be recommended to use for the control

of seed-borne diseases of Calauan Yellow Flint maize is immersion of the seeds for 7 hours in 0.1 per cent and 5½ hours in 0.2 per cent solution of this chemical. With mercuric chloride the treatments that gave beneficial results were .01 per cent for 5 hours and 0.02 per cent for 4½ hours; with Semesan 0.50 per cent and 0.75 per cent for 2½ to 3½ hours; and with Uspulun 0.5 per cent for 4 to 4½ hours and 0.75 per cent for 3½ hours.

Of the liquid treatments the results of which are shown in table 2, Germisan proved to be the best of all. Uspulun was second best and Semesan came third. The beneficial effects of these three chemicals upon corn agree with those reported by Leukel, Dickson, and Johnson (1926). Mercuric chloride and formalin, though slightly beneficial in a way, gave poorer results than either Germisan, Uspulun or Semesan. The average yield obtained from the treatment with formalin and with mercuric chloride was almost the same.

Table 2 shows also that none of the seed treatments completely rid the subsequent crop of disease in the ears. Diseased ears were obtained from both wet and dry season plantings with the exception of Uspulun-soaked seeds which did not produce any diseased ear in the dry season planting. Fewer diseased ears were obtained from the Germisan seed treatment than from any of the other chemical treatments given in table 2. The greatest number of diseased ears was obtained from mercuric chloride seed treatment.

DISCUSSION OF RESULTS

In this work it was noted that the kernels of Calauan Yellow Flint maize, although they appear healthy, may carry *Fusarium* and black, yellow, and blue molds on or within the kernels. The kernels treated with weak aqueous solutions of Germisan, formalin, Uspulun, Semesan and mercuric chloride gave a higher percentage of germination and better growth of seedlings than the control. Reddy and Holbert (1928) state that the roots of sweet corn grow rapidly into the soil and the aërial parts develop early when the treatment controlled the disease without any injury. These authors used Uspulun, Semesan, Corona 640, and other chemical dusts. Tisdale, Taylor, and Griffiths (1925) found that aqueous solutions of Germisan, Semesan, and Uspulun give excellent results in the control of barley smut. In these authors' experiments, Germisan, Uspulun, Semesan, Dipdust, Special dust, Corona 640, and Corona 640-S dusts were found to be unsatisfactory in the control of smuts of oats and barley. Leukel, Dickson, and Johnson (1926) found that dust treatment failed to give any satisfactory results in the control of barley stripe. Calma and Paderna also found that chemical dust treatment for the control of *Fusarium* and molds in the seed of Calauan Yellow Flint corn was of no avail. Of the chemicals used in solution in the laboratory and field tests they noted that Germisan was the best substance for seed treatment of corn. They found that formalin treatment was next to Germisan in laboratory tests but in field tests Uspulun was much better than formalin in the production of ears.

The results obtained by Calma and Paderna during wet and dry season plantings are in accord with those of Leukel, Dickson, and Johnson (1926). Their results also agree with those of Reddy, Holbert, and Erwin (1927) who state that sweet corn kernels treated with Uspulun solution gave a higher yield of ears than those treated with Semesan and Corona 640.

In wet and dry season plantings, Calma and Paderna noted that there was no difference in the time of emergence of seedlings between the treated and the control plants. All corn kernels in the treated and control rows emerged after three days from the time of planting. Plants from treated kernels during wet and dry season plantings were of course more vigorous and gave a better stand than those of the controls.

The treated kernels planted during the dry season produced ears that were much less infected than the treated kernels planted during the wet season. The average size of ears produced from the treated seeds during the wet and dry season crops was larger than the average size of ears produced in the control. In the wet season crop the average size of ears from the treated seeds were larger than the average size of ears from the treated seeds in the dry season crop. The ears produced from treated kernels planted during the dry season were poorer than those produced during the wet season. The difference in production between the treated seeds and the control was very marked in both the wet and dry season plantings.

The use of these organic mercury compounds is prohibitive under our present farming conditions in the Philippine Islands. As they are deadly poisonous to man and animals extreme care should be taken when handling them. However, the writers believe that, at least for technical purposes, Germisan, Uspulun and Semesan merit further tests not only with maize but with other seeds.

SUMMARY

1. *Fusarium*, black, yellow, and blue molds are the seed-borne fungi in the kernels of Calauan Yellow Flint maize.

2. The fungi are carried on the seed coat, and in the endosperm and embryo of the kernels.

3. Treatment of seeds with chemicals in the form of aqueous solutions produced beneficial effects on the seedlings in the wet and dry season plantings and controlled the seed-borne diseases. The treatments did not affect the time of emergence and the tasseling of corn.

4. Of the five chemicals used for treating the kernels for the wet and dry season plantings, Germisan gave the best results in the production of ears. Uspulun ranked second as to production of ears and control of seed-borne diseases. Semesan ranked third, and formalin, fourth. Mercuric chloride solution gave the poorest results of the chemicals used, although treated kernels produced a yield higher than the control and it reduced the amount of injury caused by seed-borne diseases.

5. More disease-free ears were produced from kernels treated with the five chemical solutions than from the control.

6. Aqueous solutions of Germisan, Uspulun, and Semesan merit further tests for seed treatment in technical ways not only with maize but with other grains or seeds. As these preparations are deadly poison to man and animals and are also expensive they will not become popular under Philippine conditions.

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TABLE 2

The effect of seed treatment upon the yield of Cuban Yellow Flint maize during the wet (W) and dry (D) seasons of 1927–1928

CHEMICALS	STRENGTH OF SOLUTION	LENGTH OF IMMERSION IN SOLUTION	NUMBER OF KERNELS PLANTED	WEIGHT OF FIVE SEEDLINGS ON AIR DRY BASIS	NUMBER OF STERILE EARS		NUMBER OF DISEASED EARS		TOTAL NUMBER OF EARS		TOTAL WEIGHT OF EARS		AVERAGE WEIGHT OF EARS		AVERAGE WEIGHT OF EARS OF ALL TREATMENTS			
															W		D	
					W	D	W	D	W	D	W	D	W	D	Treated	Control	Treated	Control
	per cent	*hours*		*grams*							*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*
Formalin	0.1	3½	10	3.5	0	0	1	1	7	6	625.0	272.0	89.28	45.33				
Control		3½	10	1.1	1	0	3	1	7	6	400.0	190.2	57.14	31.70				
Formalin	0.1	4½	10	2.4	0	0	1	0	8	6	825.7	320.1	103.21	53.40				
Control		4½	10	1.9	0	0	5	3	8	6	550.0	158.2	68.75	26.36				
Formalin	0.1	5	10	3.0	1	1	1	0	10	6	910.0	156.2	91.00	26.03				
Control		5	10	1.3	0	1	1	3	10	6	650.0	118.0	65.20	19.66				
Formalin	0.1	5½	10	3.1	0	0	2	1	9	7	713.3	258.9	79.25	36.98				
Control		5½	10	1.2	1	1	4	2	9	7	525.3	115.7	58.36	16.52				
Formalin	0.1	7	10	3.5	0	0	1	0	8	6	900.0	168.0	112.50	28.00				
Control		7	10	1.78	0	1	4	3	8	6	575.0	101.2	71.87	16.86				
Formalin	0.2	5½	10	3.6	0	0	0	1	9	7	925.4	336.6	102.82	48.08				
Control		5½	10	1.5	2	1	4	2	9	7	650.0	146.2	72.22	20.88				
Formalin	0.2	6	10	2.5	2	0	0	0	9	7	950.0	321.3	105.55	45.90				
Control		6	10	1.9	2	2	4	1	10	9	600.0	398.1	60.00	44.23	97.66	64.77	40.53	25.17
Germisan	0.25	8	10	4.1	0	0	1	0	9	7	1125.0	494.9	125.00	70.70				
Control		8	10	0.89	1	1	6	2	10	7	600.0	171.3	60.00	24.47				
Germisan	0.25	8½	10	3.8	1	0	0	0	10	9	1450.4	872.0	154.04	96.88				
Control		8½	10	1.2	0	2	6	1	7	7	750.0	217.1	107.14	31.01				
Germisan	0.50	5½	10	3.9	0	0	0	0	8	9	1050.4	699.4	131.30	77.71				
Control		5½	10	1.8	1	0	4	4	7	9	450.0	296.3	64.29	32.92				
Germisan	0.50	7½	10	4.0	0	0	0	0	10	9	1250.0	537.4	125.00	59.71				
Control		7½	10	1.6	0	0	5	3	8	8	550.0	259.4	68.75	32.42				
Germisan	0.50	8	10	3.7	0	0	1	0	9	10	1100.0	674.2	122.22	67.42				
Control		8	10	1.7	1	0	4	1	8	6	600.0	251.5	75.00	41.91				
Germisan	0.75	5½	10	3.5	0	0	0	4	9	8	1250.0	457.8	138.88	57.22				
Control		5½	10	1.94	1	3	7	4	8	8	800.9	145.7	100.11	18.21				
Germisan	0.75	6	10	2.9	0	0	0	0	9	9	1025.0	648.2	113.88	72.02				
Control		6	10	1.8	1	2	3	4	7	9	450.0	272.8	64.28	30.31				
Germisan	1.00	3	10	2.4	0	0	1	0	9	8	1000.0	693.0	111.11	86.62				
Control		3	10	1.5	1	0	3	3	7	8	475.0	305.0	67.85	38.12				
Germisan	1.00	4	10	2.7	0	0	1	0	9	9	925.0	723.6	102.77	80.40				
Control		4	10	1.9	1	0	3	3	7	9	350.0	337.9	50.00	37.54	123.91	73.04	74.29	31.88
Mercuric chloride	0.01	4	10	2.2	0	0	2	1	9	5	1025.0	102.8	113.88	20.56				
Control		4	10	1.2	1	3	3	0	7	3	350.0	31.6	50.00	10.53				
Mercuric chloride	0.01	5	10	2.4	0	0	2	1	8	6	800.8	254.2	100.10	42.36				
Control		5	10	1.98	1	0	4	1	8	6	575.0	106.6	71.87	17.76				
Mercuric chloride	0.02	3½	10	2.2	0	0	2	0	7	9	550.3	322.6	78.61	35.84				
Control		3½	10	1.3	1	1	3	3	7	8	440.5	73.8	62.92	9.22				
Mercuric chloride	0.02	4½	10	2.6	0	1	2	0	8	5	850.0	332.9	106.25	55.48				
Control		4½	10	1.2	0	0	3	1	7	6	413.0	106.5	59.00	17.75	99.71	60.94	38.56	13.81
Semesan	0.25	8	10	2.7	1	0	1	0	8	7	700.1	191.3	87.51	27.32				
Control		8	10	1.7	3	2	4	2	9	7	450.0	66.0	50.00	9.42				
Semesan	0.50	2½	10	3.2	0	1	1	0	8	7	800.5	374.4	100.06	53.48				
Control		2½	10	1.8	1	2	1	1	8	6	550.0	144.9	68.75	24.15				
Semesan	0.75	3½	10	2.8	0	0	1	1	8	7	825.0	372.0	103.12	53.14				
Control		3½	10	1.56	2	1	7	2	8	7	525.5	170.9	65.68	24.41				
Semesan	0.75	4	10	3.3	0	0	0	0	8	6	950.0	159.2	118.75	26.53				
Control		4	10	1.75	2	1	1	3	9	8	150.0	79.9	16.66	9.98				
Semesan	1.00	2½	10	2.4	0	1	2	0	8	7	900.0	177.2	112.50	35.44				
Control		2½	10	1.9	0	1	4	3	8	6	620.0	90.4	77.50	15.07	104.38	55.71	39.18	16.60
Uspulun	0.25	8	10	3.3	1	0	1	0	9	6	788.1	352.5	87.56	58.75				
Control		8	10	1.5	3	2	4	1	8	6	575.0	145.2	71.87	24.20				
Uspulun	0.50	4	10	2.8	0	0	2	0	8	8	910.9	379.1	113.86	47.38				
Control		4	10	1.4	0	2	4	2	8	6	789.5	190.1	98.68	31.68				
Uspulun	0.50	4½	10	3.2	0	0	1	0	9	6	900.0	546.1	100.00	91.02				
Control		4½	10	1.34	0	1	4	1	8	6	600.0	158.1	75.00	26.35				
Uspulun	0.75	3½	10	2.9	0	1	0	0	9	6	1250.2	313.8	138.90	39.22				
Control		3½	10	1.46	2	0	3	3	9	7	750.3	139.2	83.36	19.89				
Uspulun	0.75	4½	10	2.5	2	0	1	0	9	7	1000.0	591.9	111.11	84.55				
Control		4½	10	1.2	0	0	4	1	8	7	600.0	220.9	75.00	31.55				
Uspulun	1.00	2	10	2.9	1	0	1	0	9	6	950.0	546.6	105.55	91.10				
Control		2	10	1.23	1	1	3	2	8	7	750.0	112.4	93.75	16.06				
Uspulun	1.00	2½	10	4.0	0	0	0	0	10	6	1025.0	350.4	102.50	58.40				
Control		2½	10	1.8	4	2	0	2	9	7	600.8	230.8	66.75	32.97	108.49	80.57	67.20	26.10

THE USE OF STEAM IN KJELDAHL NITROGEN DETERMINATION[1]

F. T. ADRIANO
Of the Department of Agricultural Chemistry

WITH TWO TEXT FIGURES

The apparatus which is generally used for the distillation of ammonia in the usual Kjeldahl methods consists of tin spiral tubes arranged in a series of six, twelve or more and immersed in a water filled copper tank which serves as the condenser. The Kjeldahl flask containing the digested and alkali treated sample is connected to the upper end of a tin tube by means

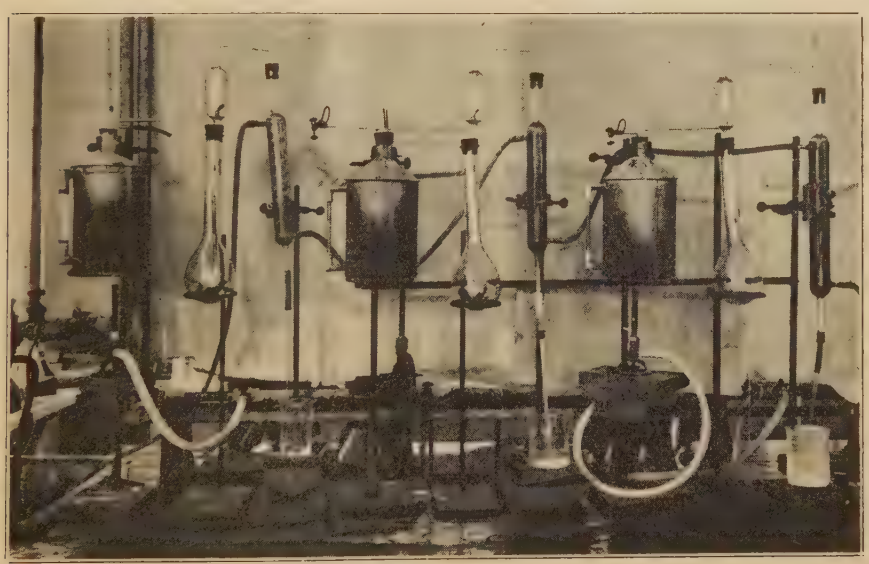

Fig. 1.—Steam generator for (ammonia) nitrogen distillation (Kjeldahl).

of ammonia safety bulb, the other end of the tube being dipped into the receiver by means of a glass tube connection. The flask is heated by means of burners. This method of distillation usually gives rise to too much bumping, frothing, and boiling over of the sample. In many cases bumping is prevented, at least partially, by the use of anti-bumping materials such as paraffin, pieces of coal, zinc, etc. One who has performed the determination of nitrogen in soils is familiar with the inadequacy of these anti-

[1]Experiment Station contribution No. 582.

bumping materials. Although the usual distillation procedure is accompanied with the difficulties named, the method is used in many laboratories and most analysts continue to use anti-bumping materials. What is surprising is that the use of steam distillation has not received general adoption. One needs only to try the method to appreciate its many advantages over the usual methods.

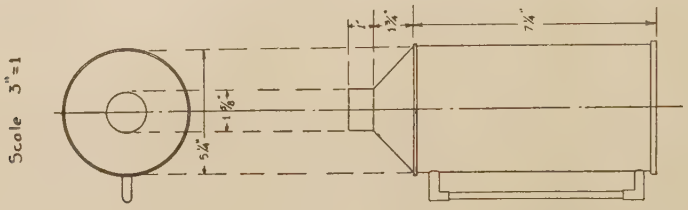

Fig. 2.—Modified Kjeldahl distilling apparatus showing steam generators.

The apparatus for the steam distillation of ammonia nitrogen can be easily set up out of ordinary Liebig condensers, ammonia bulbs, and the steam generator. This last can be made out of a plain galvanized iron sheet. One which the author is using in his laboratory with satisfactory results has the measurements shown in figure 2. A whole set-up of the apparatus is also shown in figure 1.

The author is indebted to Professor Geo. W. Cavanaugh of Cornell University for the idea of setting up the ammonia distilling apparatus with the use of steam.

ACCURACY IN THE WEIGHING OF EXPERIMENTAL CHICKENS[1]

F. M. FRONDA
Of the Department of Animal Husbandry

The use of poultry, both inside and outside the laboratory, has become very general in various studies owing to the ease with which these animals adapt themselves to changes in environment. In many of these studies, the weights of the individuals are often the criteria used in the determination of the effects of the treatment to which they are subjected. Because of the daily activity of fowls made necessary by their habits in search for food it would seem that these weights may vary somewhat at different hours of the day. The factors which may cause variations in the weights of chickens at different hours of the day are, in the main, intake of feed and water and movement of the bowels.

In weighing experimental chickens, to overcome the effects of these various factors, it is usually recommended that the chickens be weighed regularly at certain hours of the day. The weighing is usually done early in the morning just before the birds are given their first meal for the day. Atwood (1928)[2] claims that at this time "the body weight may be obtained more accurately than later in the day when the amount of feed in the digestive system is more variable, also the laying of the birds is not interfered with, and they can be caught with a minimum of trouble and confusion". If this recommendation is followed, it necessitates, when a considerable number of chickens are weighed, delaying the breakfast of the fowls for some time. With hens this delay may influence their laying. To find a means by which the experimenter with fowls may be aided in the work of weighing his experimental animals was the object of this study.

The important questions that confront the poultry investigator are: Do the chickens have to be weighed at certain definite hours of the day to get uniform results? To what degree of accuracy must the chickens be weighed? Are the variations in the weight of the chickens due to the necessary vital activities of the birds so large as to cause significant differences in the results obtained? These questions and others are answered by the data given in this paper.

Literature along this line, is very meager. The only available study reported is that by Card (1920)[3] whose studies with laying hens included

[1] Experiment Station contribution No. 583. Read at the meeting of the Los Baños Biological Club on October 4, 1928. Received for publication November 12, 1928.

[2] Atwood, Horace. 1928. Notes on weighing mature fowls in experimental work. Poultry Science **7**: 67–68. *Fig. 1–2.*

[3] Card, Leslie E. 1920. What precision is worth while when weighing hens? Journal of the American Association of Instructors and Investigators in Poultry Husbandry 7: 7–8.

the weighing of forty-nine S. C. White Leghorns at hourly intervals from 8:00 a. m. to 6:00 p. m. From his studies he concluded that the greatest accuracy was obtained by weighing at 1:00 p. m. According to his report the differences of the mean weights, however, were small, and it is very doubtful whether these differences would be significant if their probable errors were determined and compared. The birds were given a light normal feeding of grain at 8:30 a. m. and a heavy feeding at 5:15 p. m. Dry mash, grit, oyster shell, and water were available throughout the day.

The writer could find no recommendation concerning the weighing of chickens other than layers. Young chickens are commonly employed as laboratory materials in nutrition and other studies. For this reason in this study the weighing of young as well as of mature chickens was studied with the view of determining just what the best system of weighing should be in order to get the most accurate weights possible. In the present report, the data include the weights of 68 Cantonese chicks one week old, the weights of 35 weanling Cantonese chickens eight weeks old and the weights of 48 mature Cantonese pullets. The last group varied from about 8 to 14 months in age.

The birds were weighed in a pan balance sensitive to one one-hundredth of a gram. The weights of each group were determined in one day at intervals of two hours, from 6:00 a. m. to 6:00 p. m. Weighing at one hour interval will interfere very materially in the day-to-day activities of the chickens. This is true especially with the young chicks which are not benefited by too much handling. Besides, the chickens will be prevented from feeding normally if they are handled at intervals closer than two hours, as it took slightly over a minute to weigh each individual accurately enough for the purposes of this study.

The chickens weighed were treated in as normal a way as possible. All were given a light grain feeding about 7:00 a. m., the chicks a heavy grain feeding about 4:00 p. m., and the mature fowls about 5:00 p. m. Dry mash was open to them at all times. In addition to this, about 11:00 a. m., they were given wet mash enough to last them about fifteen minutes. Water and grit were available throughout the day.

RESULTS

The results obtained in this study are given in tables 1 to 6. In table 1, the variations in the mean weights of the different groups of chickens used are given together with their respective probable errors. The averages for the day were determined by adding the bi-hourly weights to get the individual average weights for the day, and the means of these were determined. These are given in the last line of table 1. In this connection the following question may be asked: Can these averages be taken to express the real weights of the fowls for the day? There is no apparent reason why they may not as they represent the weights of the birds determined at bi-

hourly intervals throughout the same day. Then, how would the weights determined at each weighing compare with these "real" weights of the birds? To answer this question, reference should be made to table 2. The differences between the mean weights taken at intervals of two hours and the average of these weights for the day, together with their probable errors are given in this table.

It is of interest to make comparisons of the mean weights determined at different intervals, two, four, and six hours, to see if the variation at these different hours are significant. These mean weights with probable errors, are given in tables 3, 4, and 5, respectively. Table 6 gives the differences between the mean weights determined at six o'clock in the morning and at six o'clock in the evening.

DISCUSSION

By reference to table 1, it may be seen that in all the three groups of chickens studied, the mean weights varied in practically the same way. The mean weights determined at 6:00 a. m. increased after the morning feeding of grains. In the case of one-week old chicks, very little weight is added from this hour up to 12:00 noon, but in case of the larger birds, the feeding of the wet mash before noon caused an increase in the weight at twelve. Both the one-week old chicks and the weanlings slightly increased in weight from 12:00 noon to 4:00 p. m., when the maximum weights for the day were registered in both groups. After 4:00 p. m., the chicks in both groups were practically idle, waiting for the roosting hours in the evening, hence their weights either decreased, as was the case with the week-olds, or were maintained, as with the weanlings. A slightly different story is presented by the mature fowls. From 12:00 m. to about 4:00 p. m., these birds were idle, or, in most cases, they were laying eggs. So, during these hours they did not fill up with feed, hence the weight was either maintained or because of the heavy egg production which generally takes place some time during these hours the weight was decreased. Then, as soon as they get a chance, the fowls fill up for the evening, registering the highest weight for the day, at 6:00 p. m. A similar variation was observed by Card (1920)[4] among White Leghorn hens.

From the probable errors of these different determinations it may be seen also that it will not be worth while to carry the weights of mature fowls closer than fifteen grams, of the weanlings, five grams, and of the one-week old chicks one-half gram. The weights of the hens were observed to be most variable early in the morning, a fact contrary to general expectation. The claim of Atwood (1928)[5] that about this time the body weight may be obtained more accurately than later in the day may be true if the chickens are not allowed to leave the roost before they are weighed. In this study, however, the birds were allowed out from daylight to weighing time at 6:00

[4], [5] *loc. cit.*

a. m. The "early birds" had a chance to go around and pick up whatever grain may have been left from the previous evening grain meal and in addition they obtained some food from the mash hoppers. The worms and insects and green grass that these "early birds" picked up from the yards also contributed to the variation.

If the averages of the bi-hourly weights are taken as the real weight of the fowl on that day, a comparison of the differences between these weights and the average for the day, as may be seen in table 2, reveals the fact that among the weanling and the yearling chickens, these differences are not significant. With the one-week old chicks, these differences are not significant except those recorded at 6:00 a. m. and those taken at 5:00 p. m. The mean weight at 8:00 a. m. and that at 2:00 p. m. are only fairly significant. Outside of these in all the groups of chickens weighed, the differences are not significant. Thus, it is very significantly shown that experimental fowls may be weighed at almost any hour of the day and the weights thus obtained will be close enough to the real weight of the fowls, and the difference will be small enough to be within the limits of its probable error.

When the mean weights of the fowls in all groups determined at intervals of two and four hours are compared, it may be seen in tables 3 and 4 that the differences between them are also not significant. However, among one-week old chicks, if the interval between the weighing is stretched to six hours, as for example between 6:00 a. m. and 12:00 m., the differences between the means become significant. Thus, if one set of weights is taken at a certain hour, and another set is taken six hours later on the same day, the means of these weights according to the results of this study will vary, and this variation is significant. This is true only in the case of the one-week old chicks; it does not hold as the chickens grow older.

The differences between the early morning weights and those taken in the evening of the same day are significant in all the groups of chickens weighed. In practice, however, weighing at such wide intervals is not done, and therefore errors arising from this source may be considered practically nil. It may be safely concluded, therefore, that experimental chickens may be weighed almost any time of the day and variations in the weights are not significant, except when one weighing is made early in the morning and another is made at 6:00 p. m.

SUMMARY OF CONCLUSIONS

1. The weights of chickens vary throughout the day, the amounts of these variations depending upon the size and the activity of the fowls. These variations, however, are not great enough to be significant.

2. It was concluded that in weighing experimental chickens it is not worth while to carry the weights of mature fowls (Cantonese) closer than fifteen grams, of the weanlings, five grams, and of one-week old chicks, one-half gram.

3. Weanling and yearling chickens may be weighed at any hour of the day and the weight will be close enough to the real weight of the bird for the day. If young chicks are weighed about noon the weight will be within a close range of the real weight for the day.

4. The differences between mean weights taken at intervals of two and four hours are not significant.

5. The differences between mean weights taken at intervals of six hours is significant only among young Cantonese chicks, but not among weanling and yearling chickens.

6. The difference between early morning weights and those taken in the evening are significant in all groups of chickens used in this study.

TABLE 1

Mean weights of Cantonese chickens determined at intervals of two hours, from 6:00 a. m. to 6:00 p. m.

TIME	ONE WEEK OLD	EIGHT WEEKS OLD	YEARLINGS
	grams	*grams*	*grams*
6	35.04±0.464	137.07±4.334	1283.82±23.452
8	36.57±0.489	142.79±3.946	1305.71±17.184
10	37.15±0.528	142.21±4.137	1315.09±17.032
12	37.87±0.527	145.07±4.617	1331.74±16.461
2	39.99±0.575	148.50±4.619	1331.74±16.920
4	40.21±0.564	152.50±4.843	1323.48±15.592
6	39.29±0.502	152.50±4.810	1348.42±16.201
Average for the day	37.91±0.559	146.12±4.430	1320.33±16.257

TABLE 2

Differences between mean weights taken at intervals of two hours and the average of these weights for that day

	ONE WEEK OLD	EIGHT WEEKS OLD	YEARLINGS
AVERAGE / TIME	*grams*	*grams*	*grams*
	37.91±0.559	146.12±4.430	1320.33±16.257
6	−2.87±0.726	−9.05±6.197	−36.50±28.535
8	−1.34±0.743	−3.03±5.916	−15.62±23.656
10	−0.76±0.770	−3.91±6.061	− 4.24±23.545
12	−0.04±0.768	−1.05±6.398	11.41±23.136
2	2.08±0.737	2.38±6.400	11.41±23.464
4	2.30±0.787	6.38±6.563	3.15±22.523
6	1.38±0.751	6.38±6.538	28.09±22.951

TABLE 3

Differences between mean weights taken at intervals of two hours

TIME	ONE WEEK OLD	EIGHT WEEKS OLD	YEARLINGS
	grams	*grams*	*grams*
6 and 8	1.53±0.674	5.72±5.861	21.88±29.073
8 and 10	0.58±0.719	0.58±5.717	9.28±24.195
10 and 12	0.62±0.746	2.86±6.198	16.65±23.687
12 and 2	2.12±0.778	3.43±6.530	O
2 and 4	0.23±0.803	4.00±6.692	8.26±23.005
4 and 6	0.92±0.775	O	24.94±22.470

TABLE 4

Differences between mean weights determined at intervals of four hours

TIME	ONE WEEK OLD	EIGHT WEEKS OLD	YEARLINGS
	grams	*grams*	*grams*
6 and 10	2.11±0.702	5.14±5.991	31.26±28.983
8 and 12	1.30±0.718	2.28±6.073	26.03±23.796
10 and 2	2.84±0.778	6.29±6.201	16.65±24.007
12 and 4	2.34±0.779	7.43±6.691	8.26±22.671
2 and 6	0.70±0.761	4.00±6.668	16.68±23.425

TABLE 5

Differences between mean weights determined at intervals of six hours

TIME	ONE WEEK OLD	EIGHT WEEKS OLD	YEARLINGS
	grams	*grams*	*grams*
6 and 12	2.83±0.702	8.00±6.332	47.91±28.652
8 and 2	3.42±0.752	5.71±6.075	26.03±24.115
10 and 4	3.06±0.772	10.29±6.369	8.37±23.089
12 and 6	1.42±0.727	7.43±6.667	16.68±23.096

TABLE 6

Differences between mean weights determined at 6:00 a. m. and at 6:00 p. m.

AGE	DIFFERENCE	PROBABLE ERROR	REMARKS
	grams		
One week	4.25	± 0.683	Significant
Eight weeks	15.43	± 6.473	Fairly significant
Yearlings	64.59	±28.503	Fairly significant

YIELDING POWER OF PEANUTS FROM CUTTINGS OF DIFFERENT AGES[1]

P. A. RODRIGO
Of the Department of Agronomy

WITH THREE TEXT FIGURES

That some varieties of peanuts may be grown from cuttings under field conditions has been reported by the writer.[2] In the present paper the result of a short study on the determination of the yielding power of peanut cuttings from plants of different ages is reported.

The study was conducted in the Experiment Station field of the Division of Farm Crops of the Philippine College of Agriculture during the College year 1927–28 in connection with the course in Agronomy 13 (cereals and field legumes). The experiment was started on June 1, 1927, and closed on January 20, 1928.

MATERIALS AND METHODS

Three varieties of peanuts; namely, Kinorales, Lemery, and Tarlac were used in this experiment. So as to have cuttings from plants of different ages available for planting on the same date, seeds of the three varieties used were planted on June 1, July 4, and August 4, 1927. Cuttings from these plantings were planted in thoroughly prepared ground on September 29, 1927. This means that the cuttings used were taken from plants which were about two months, three months, and four months old, the last set being almost matured.

The different kinds of cuttings of the varieties used were planted side by side, each kind occupying two rows. The rows were 30 meters long and 80 centimeters apart. The cuttings were set at 30 centimeters intervals in the rows, with one cutting to the hill. For comparison, seeds of the different varieties were planted in adjacent rows. During the progress of the experiment, all the plants were cultivated and weeded in practically the same manner. In the last cultivation the soil was worked toward the plants, thus forming ridges along the rows of plants.

EXPERIMENTS AND RESULTS

The percentage of germination of the peanut seed and the percentage of rooting of the different kinds of cuttings were determined. The data

[1] Experiment Station contribution No. 584. Received for publication, September 20, 1928.

[2] Rodrigo, P. A. 1927. Growing peanuts from cuttings. THE PHILIPPINE AGRICULTURIST **16**: 13–18. *Pl. 1; fig. 1–2.*

are presented in tables 1 and 2. Table 1 presents the data for the individual varieties and table 2 is a summary of table 1.

The cuttings which were taken from plants of different ages showed marked differences in their rapidity to root and develop. The younger the cutting, the more rapid was the recovery. Figure 1 shows clearly the differences in the vegetative development of the cuttings of different ages.

When the plants were beginning to develop pods, there was a dry spell. All of the plants suffered from the effect of the drought, but the effect was very pronounced in the case of the plants propagated by cuttings. Upon examining the plants, it was found that the cuttings had poorly developed

Fig. 1.—Plants forty-two days old grown from cuttings from (*a*) two months old, (*b*) three months old, and (*c*) four months old plants. (All photographs taken by the Photographic Division, College of Agriculture.)

root systems. The differences in the stand of the plants from seed and from cuttings and in their ultimate production may be traceable to the effect of the dry spell upon the development of the root systems.

At maturity, samples for the determination of the yield of straw and of pods were taken at random from the rows of all the propagating materials used. The soil adhering to the plants was washed off carefully with water before they were dried in the sun. The air-dry weight of the straw and of the pods of each plant was then taken.

The average yields of pods and of straw per hill or per plant including their respective probable errors were computed. Table 3 presents the

average yields per plant of the three varieties used and table 4 is a summary of table 3.

DISCUSSION OF RESULTS

Germination and rooting

The cuttings from plants two months, three months, and four months (maturing) old were able to produce plants that matured normally. There were, however, great differences in the percentage of their rooting, in their ability to recover and to develop vegetatively, as may be seen in figure 1; also in their producing power, as will be discussed later. There was very slight difference in the number of days to maturity; plants from seed and from cuttings matured at practically the same time, with those from the older cuttings showing a tendency to mature a bit later.

Fig. 2.—Matured Kinorales plants grown from cuttings of: (*a*) two months old, (*b*) three months old, and (*c*) four months old (maturing) plants.

In tables 1 and 2 are presented the percentage of germination of the seed and the percentage of rooting of the different kinds of cuttings. One very significant thing to note is that while the three varieties used showed differences in the percentage of rooting in the three ages of propagating material, the differences were constant. That is, the cuttings from the three months old plants gave the highest percentage of rooting in all varieties, followed by those from two months old plants; and the lowest percentage of rooting was obtained from cuttings taken from four months old, or maturing plants. The cuttings from variety Kinorales gave the best percentage of rooting; 98 per cent for the three months old cutting, 89 per cent for the two months old cutting and 76 for the four months old cutting. Variety Lemery gave fairly high percentages of rooting as may be seen in

table 1, but variety Tarlac had a rather poor percentage of rooting, 72.5 per cent for the two months old cutting, 70.5 for the three months old cutting and 12.5 per cent for the four months old cutting. The peanut seed of all the varieties used gave very poor percentages of germination because of the destruction of seed by ants; 13.5 per cent for Tarlac, 37.0 per cent for Kinorales and 21.0 per cent for Lemery. This low percentage, however, undoubtedly, gave the plants that grew ample room for rapid and vigorous development.

As to the average percentage of rooting of the three varieties, the cuttings from three months old plants had 88.00 per cent; those from two months old plants, 83.00; those from four months old plants, 55.50; and the seed, 23.85 per cent. In ability to root and grow, the cuttings from

Fig. 3.—Matured Lemery plants grown from cutting of: (*a*) two months old, (*b*) three months old, and (*c*) four months old (maturing) plants.

three months old plants were the best and those from maturing plants were the poorest.

Straw and pod yield

Straw yield. The average straw yields of the different propagating materials are presented in table 1. In all the three varieties, the plants from seed gave the highest straw production, the yield per plant being 26.2 ± 1.085 grams for Kinorales, 23.1 ± 1.203 grams for Lemery, and 8.1 ± 0.537 grams for Tarlac. While the plants from the cuttings of the youngest plants, (two months old) gave the highest yield, the differences were only slight for the different cuttings.

Pod production. In tables 3 and 4 are found the average yield of pods per plant of the propagating materials under study. As in the case of the

straw yield, the plants from seed gave the best production in all the varieties. The reason for the plants from cuttings giving lower pod production may have been the effect of the dry spell, as they had the poorer root systems. This dry weather was during the development of pods.

Of the plants from cuttings, those from young (two months old) plants gave the highest yield of pods per plant, and those from maturing (four months old) plants gave the lowest yield. Taking the average of the three varieties, the plants from two months old cuttings, gave 10.1 ± 0.372 grams of pods per plant; those from three months old cuttings, 8.2 ± 0.379 grams; and those from four months old cuttings, 6.7 ± 0.335 grams of pods. The difference between the pod production of the plants from two months old cuttings and those from three months old cuttings was significant, but the difference between those from three months old cuttings and from four months old cuttings was very slight.

It is significant and worth noting that while the three months old cuttings gave the highest percentage of rooting, the plants from two months old cuttings gave the highest production of straw and of pods. Since the two months old cuttings had a comparatively high percentage of rooting (83 per cent) they proved to be better for planting purposes. The cuttings from old or maturing peanut plants showed no economic value for planting purposes.

Although the best producers of pods and of straw among the plants from cuttings did not produce as much as the plants from seed, the use of peanut cuttings for planting purposes seems to have a place in the peanut industry. One of the direct causes of the small area devoted to peanut raising in the Philippines is the lack of good seed during the planting season. The area planted to peanuts could be increased by making a second planting by cuttings about 40 to 60 days after the peanut seed had been planted, which is in the early part of the rainy season. If a farmer would thus increase the area planted he could afford to increase his handling capacity. The method of peanut growing in the Philippines is such that it limits the area that can be handled by a farmer, mainly because of the absence of machinery to pick up and clean the pods.

SUMMARY OF CONCLUSIONS

From the data presented in this study the following conclusions may be drawn:

1. Cuttings from peanut plants of different ages, varying from two months old plants to four months old (maturing) plants were capable of rooting when planted under Los Baños field conditions. The cuttings from the three months old plants in the three varieties used had the highest percentage of rooting (70.5 to 98.0 per cent), those from the two months old plants had second highest (72.5 to 89.0), and those from maturing plants gave the lowest (12.5 to 78.0 per cent).

2. Of the plants from cuttings those from the two months old plants gave the highest pod yield; those from the three months old plants, second; and those from maturing plants, lowest. The average pod production of the three varieties was 10.1 ± 0.372 for the plants from two months old cuttings, 8.2 ± 0.379 from three months old, and 6.7 ± 0.335 grams from four months old.

3. In the straw production, there was only a slight difference in the average yield per plant; this was in favor of the plants from the two months old cuttings.

TABLE 1

Showing the percentage of germination of peanut seeds and of rooting of peanut cuttings of different ages

	NUMBER PLANTED	NUMBER GERMINATED OR ROOTED	GERMINATED OR ROOTED
			per cent
Kinorales:			
Seed	200	74	37.0
Cuttings from 2 months old plant	200	178	89.0
Cuttings from 3 months old plant	200	196	98.0
Cuttings from 4 months old plant	200	152	76.0
Lemery:			
Seed	200	42	21.0
Cuttings from 2 months old plant	200	175	87.5
Cuttings from 3 months old plant	200	191	95.1
Cuttings from 4 months old plant	200	156	78.0
Tarlac:			
Seed	200	27	13.5
Cuttings from 2 months old plant	200	145	72.5
Cuttings from 3 months old plant	200	141	70.5
Cuttings from 4 months old plant	200	25	12.5

TABLE 2

Showing the average percentage of germination of seed and of rooting of cuttings of different ages of three varieties of peanut

	PLANTED	GERMINATED OR ROOTED	GERMINATED OR ROOTED
			per cent
Seed	200	47.7	23.85
Cuttings from 2 months old plants	200	166.0	83.00
Cuttings from 3 months old plants	200	176.0	88.00
Cuttings from 4 months old plants	200	111.0	55.50

TABLE 3

Showing the comparative pod and straw production of peanut cuttings from plants of different ages

	AVERAGE YIELD PER PLANT	
	Pod	Straw
	grams	*grams*
Kinorales variety:		
Plants from seed	29.3±1.089	26.2±1.085
Plants from 2 months old cutting	12.0±0.335	15.8±0.890
Plants from 3 months old cutting	11.8±0.486	14.4±0.598
Plants from 4 months old cutting	9.1±0.324	13.0±0.741
Lemery variety:		
Plants from seed	14.9±0.812	23.1±1.203
Plants from 2 months old cutting	11.3±0.483	13.9±0.807
Plants from 3 months old cutting	8.5±0.391	13.8±0.627
Plants from 4 months old cutting	7.7±0.301	16.6±0.702
Tarlac variety:		
Plants from seed	9.4±0.839	8.1±0.537
Plants from 2 months old cutting	6.9±0.298	5.7±0.313
Plants from 3 months old cutting	4.3±0.262	3.9±0.329
Plants from 4 months old cutting	3.3±0.391	5.6±0.692

TABLE 4

Showing the average pod and straw production per plant of three varieties of peanuts

Pod production

	YIELD	DIFFERENCE	SIGNIFICANCE OF DIFFERENCE
	grams	*grams*	
Plants from seed	17.9±0.913		
Plants from 2 months old cutting	10.1±0.372	−7.8±0.986	significant
Plants from 3 months old cutting	8.2±0.379	−1.9±0.531	significant
Plants from 4 months old cutting	6.7±0.335	−1.5±0.505	slight

Straw production

Plants from seed	19.1±0.942		
Plants from 2 months old cutting	11.8±0.670	−7.3±1.155	significant
Plants from 3 months old cutting	10.7±0.518	−1.1±0.846	slight
Plants from 4 months old cutting	11.7±0.712	1.0±0.883	insignificant

SUGAR CANE BREEDING IN THE COLLEGE OF AGRICULTURE V: ISOLATION OF LIVE CANE ARROWS AND THEIR USE FOR HYBRIDIZATION[1]

TORIBIO MERCADO
Of the Department of Agronomy

WITH TWO TEXT FIGURES

Much of the success in hybridization work depends on the technique used. This is especially true with sugar cane plants. Realizing this truth, cane breeders in different countries have tried to improve the methods used in cane hybridization. In this College, for instance, we have tried to train cane stalks so that their flowers may be handled conveniently without the operator's using a platform on which to stand to reach the inflorescence. In India Venkatraman (1926)[2] successfully isolated live arrows by potting cane stalks in earthen pots. In the present experiment attempts were made to use bamboo pots as bamboo is cheap and easily obtained in almost every part of the Philippines. This work in potting cane stalks was carried further in other respects than Venkatraman reported.

This experiment was conducted in the Plant Breeding garden, College of Agriculture, Los Baños, during the 1926–1927 and 1927–1928 sugar cane flowering seasons. The work would have been finished in the 1926–1927 season, had it not been for the typhoon that occurred in November, 1926 which destroyed nearly all the cultures. Only a part of the observations was taken that year. The report was completed in the 1927–1928 season.

The objects of this experiment were: (*a*) To find out whether or not cane stalks can be isolated from the mother plant by rooting them in bamboo tubes for use in hybridization operations; (*b*) to find out the effect of potting upon the production of seeds.

MATERIALS AND METHODS

Sugar cane varieties used

Two types of sugar cane varieties were used in this study; namely, the thick soft and the thin hard types. The thick soft type was represented by varieties, Badila, H–109, New Guinea 24 B, Cebu Purple, Louisiana Striped, 2727 POJ, Mauritius Malagache, D. I. 52, Yellow Caledonia,

[1] Experiment Station contribution No. 585. Prepared in the Department of Agronomy under the direction of Dr. N. B. Mendiola. Received for publication September 13, 1928.

[2] Venkatraman, T. S. and R. Thomas. 1926. Sugarcane-breeding technique—Isolation of live arrows from undesirable pollen through artificial rooting of canes. The Agricultural Journal of India **21**: 203–209.

Caledonia Ribbon, Red Tanna, Black Tanna, Striped Tanna, C. A. 12735, C. A. 15723, P. B. 117, P. B. 119, P. B. 148, P. B. 149, and other promising seedling canes bred at the College. Of the thin hard type, Hind's Special, Toledo, C. A. 12797, C. A. 14797, Chinois, and C. A. C. 87, were tried.

Potting materials

Large-sized bamboo stalks with an outside diameter of about 13 cm. were selected. The stalks were cut into sections about 30 cm. long and containing an internode. Each section forms a bamboo pot. Each bamboo pot was cut into halves lengthwise and a half of circular hole large enough to admit a cane stalk (see fig. 1) was made in the joint of each half. For

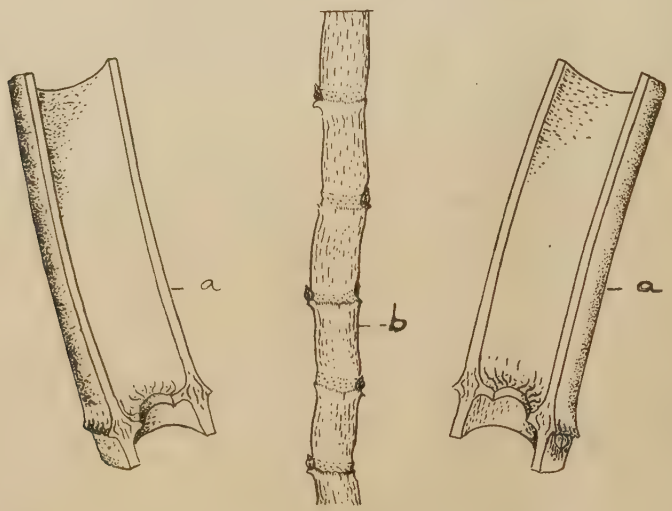

Fig. 1.—*a* Two bamboo halves showing the hole made at the joint; *b* and a lower portion of a cane stalk convenient for potting.

tying the two halves of a pot together wire No. 18 or No. 22 was used as this size is easily tightened with a pair of pliers. Abaca bracts or strong vines can be used instead of wire. When the pots used were small, a second potting was made. Empty petroleum cans, boxes, or similar containers were used for repotting. If a can was used one end was removed and holes made in the other end for drainage. Ordinary garden soil or the soil at the base of the cane plant was used for potting.

Potting

Potting was begun as soon as the cane stalks showed signs of arrowing. Healthy stalks were selected in the field and labeled. Standing stalks were preferred. Recumbent stalks were supported with poles so that the pots

would be either in a slanting or an upright position. The bamboo pots previously prepared were taken to the field and each half was partly filled with soil. Then the two halves were brought close to a stalk to be potted

Fig. 2.—*a*. Two bamboo halves each filled with soil and placed near the cane stalk for potting; *b*. a man preparing pieces of wire for tying; *c*. another man tying the two bamboo halves tightly.

and closed around it. The halves were then tied together with wire and the pot tied to another stalk of the same stool or to a pole. The process of potting is shown in figure 2. The potted stalk was supported by a pole to prevent its lodging. Enough additional soil was put in the pot to cover

two to three nodes of the stalk and pressed a little around it. The stalk was watered immediately after potting. To encourage the early development of roots the soil in the pot was kept moist. The upper portion of the stalk about 30 cm. below the last green leaf sheath was potted.

When the potted stalk had produced abundant roots and the inflorescence could be seen at the top of the topmost leaf sheath, the stalk was cut off just below the pot. The severed stalk was taken to a shed for observation. When repotting was desired the wire was untied from around the pot and the bamboo halves were removed carefully from the rooted portion without loosening the soil. The stalk was then placed in an empty petroleum box or can which was carefully filled with soil which was pressed down to keep the stalk in position. Great care was taken to keep the stalk from turning as this would loosen the soil clinging to the roots and they might be injured. A strong pole was stuck near the can and the stalk was tied to it. When long stalks were potted two or more poles were used for support.

The same process of potting was used with all the varieties used in the two types of canes. In the first year of the experiment it was found that the thin type of cane did not produce roots readily; their development was rather late and slow. By the time the thick soft type had produced an abundance of roots the thin hard type had sent out only a few roots. This observation led to the seeking of other methods of potting the thin type. One method tried was to plant cane points of C. A. C. 87 variety in boxes 33 by 26 by 26 cm. and place them in the cane field. Another method tried was to pot the selected stalks of same variety about a month or more before flowering commenced. Early potting was done to give more time for the stalk to develop roots.

Observations

After potting, observations were made. The time from potting to the time when roots were abundant was noted. Under the shade after cutting, the wilting of leaves and the protrusion of the arrows were observed daily. Other points noted were the opening of the flowers, the dehiscence of anthers, and the production of seeds and seedlings. The ripe seeds of the potted stalks were collected and taken to the laboratory. Several arrows of untreated stalks were collected to serve as control. Seeds of potted and unpotted arrows were grown separately and the number of seedlings produced was counted.

Checkerboard system of planting

In this experiment a checkerboard planting was made in several plots for comparison. Fifteen varieties were planted. Each pair of thick soft and thin hard varieties was planted in alternate rows. The cuttings were planted at a distance of 75 cm. each way. The plot was given uniform treatment during the progress of the work. Observation on the date of

flowering of the different varieties was made. After the first crop was harvested, the varieties were ratooned. At the age of four months the ratoon stalks of the different varieties were counted.

TABLE 1

Age of plants potted and number of seedlings produced

VARIETY NAME	DATE POTTED	DATE CANE WAS CUT	TIME FROM POTTING TO CUTTING	TREATMENT AFTER CUTTING	SEEDLINGS OBTAINED
	1927	1927	*days*		
C. A. 12735	October 22	November 4	13	Repotted	None
C. A. 12735	October 22	November 5	14	Repotted	7
C. A. 12735	October 22	November 6	15	Repotted	27
C. A. 12735	Control	Control	—	——	100
P. B. 270	October 22	November 8	17	Repotted	640
P. B. 270	October 22	November 2	11	Repotted	618
H–109	October 13	November 3	21	——	1
H–109	October 13	November 3	21	——	3
H–109	October 13	November 3	21	——	32
H–109	Control	Control	—	——	911
H–109	Control	Control	—	——	170
H–109	Control	Control	—	——	558
New Guinea 24B	October 22	November 8	17	Repotted	5
New Guinea 24B (bagged)	Control	Control	—	——	None
New Guinea 24B (bagged)	Control	Control	—	——	3
New Guinea 24B (bagged)	Control	Control	—	——	7
P. B. 202	October 12	November 4	23	——	135
P. B. 219	October 12	November 4	23	——	540
P. B. 219	October 12	November 4	23	Repotted	682
P. B. 197	October 22	November 6	15	Repotted	340
P. B. 197	October 22	November 6	15	Repotted	None
P. B. 208	October 22	November 6	15	Repotted	16
P. B. 176	October 12	November 3	22	——	682
P. B. 185	October 12	November 6	25	——	306

RESULTS

The results of the present experiment are presented in tables 1 and 2.

Table 1 gives the number of days from first potting to severing of stalks from the mother plant and the number of seedlings obtained from the potted stalks and from the control.

Table 2 gives the tillering habits of the thick soft and thin hard types of sugar cane.

DISCUSSION OF RESULTS

The belief that not all cane varieties flower and not all varieties that flower can be used for crossing was confirmed during the progress of this experiment. Flowers of some cane varieties are self or cross fertile. Flowers of Yellow Caledonia, Red Tanna, Striped Tanna, Black Tanna,

and Caledonia Ribbon produced neither pollen nor stigma. 213 POJ produced very few pollen grains but the stigmas opened normally. When the flowers of Chinois and Uba opened, the stigmas were normal, but the pollen grains were very few in number. Negros Purple opened its flowers very late and produced pollen very sparsely. As to whether these few pollen grains were viable or not, the writer did not take time to investigate for although they might be viable there was less chance of cross pollination with them than with the varieties well supplied with pollen when used as "fathers". D. I. 52 and Toledo reached the booting stage only and their flowers did not come out at all.

TABLE 2

Tillering habits of two distinct types of sugar cane under checkerboard system of planting

VARIETY NAME	HILLS ORIGINALLY PLANTED	HILLS CUT TO FIRST RATOON	TOTAL NUMBER OF STALKS AFTER FIRST RATOON	AVERAGE NUMBER OF STALKS PER STOOL	CONDITION OF THE PLANT
Thick soft type					
H–109	25	21	127	6	No disease
Goru	25	20	42	2	1 stalk attacked by Fiji disease
B–247	25	18	81	5	21 stalks attacked by Fiji disease
P. B. 119	25	10	37	4	2 stalks attacked by mosaic
P. B. 117	25	12	40	3	5 stalks attacked by mosaic and 7 attacked by Fiji disease
P. Purple	—	27	175	6	42 stalks attacked by Fiji disease
C. Purple	25	12	89	7	39 stalks attacked by Fiji disease
Badila	24	18	91	5	7 stalks attacked by Fiji disease
Luzon White	—	30	136	5	5 stalks attacked by Fiji disease
Average number of stalks				5	
Thin hard type					
Chinois	25	25	447	18	No disease
Toledo	35	31	329	11	No disease
C. A. C. 87	30	29	506	17	No disease
Japanese Cane	5	5	59	12	No disease
Uba	—	3	66	22	No disease
Hind's Special	—	4	55	14	No disease
Average number of stalks				16	

Potting and potting materials. Potting was found to be an easy method of rooting sugar cane stalks. The abundance of bamboo plants in the

Philippines made it possible to prepare bamboo pots at a very low cost. Stalks that had small or developing roots when potted sent out roots earlier than those that did not have any at all. The age of the stalk was found to have something to do with the formation of roots. Young stalks did not send out roots as readily as the old ones. They usually did not flower. The lower portion of the stalk sent out roots earlier than the top portion.

Potting the thick soft type. The thick soft type behaved differently from the thin hard one. The roots of this type developed faster and earlier than the thin hard type. In less than three weeks the stalks produced abundant roots in the pot.

Potting the thin hard type. It is very interesting to note that this type of cane sent out its roots later than the thick soft type. In most potted stalks few roots were found three weeks after potting. Three weeks old stalks of potted thin hard type wilted although they were placed under a breeding shed and given good care. It was found necessary to pot this type a month or more before flowering began. The cuttings planted directly in pots developed more than three stalks while the stalks potted before flowering had only one stalk to a pot. Cane points planted in a box tillered similarly to those planted in the field. Repotting was found necessary if the bamboo pots were small or when the severed stalks were intended for ratooning.

Care and treatment of the potted arrows. The development of the potted arrows depended upon the care and treatment given to the newly cut stalks. If the arrows of the potted stalks protruded gradually the flowers opened normally, the anthers, dehisced, and fuzz matured.

Seeds of the potted or repotted stalks grew as well as those of the unpotted ones (see table 1). The production of seeds depended upon the care of the cut stalks. If the potted stalks were neglected, they wilted and ultimately died, hence no seed was produced. The results showed that if a potted or repotted stalk of a fertile variety was well cared for, it produced many seedlings. P. B. 219 which was potted and repotted gave 682 seedlings to the arrow. The potted arrow of P. B. 176 gave nearly 700 seedlings.

Checkerboard planting of canes. The checkerboard system of planting different varieties of sugar cane was found an aid in cross pollination. In the first generation, with the plant canes, all the varieties planted grew very well, and the arrowing stalks usually flowered. However at the first and second ratoons there was varietal struggle for existence. The thin hard type was more resistant to disease and hardier than the thick soft type. As the thin hard type shaded the thick soft type the latter lost its ability to tiller freely and became slender, sickly, and later on died.

As may be seen in table 2, the two distinct types when planted side by side vary greatly in their tillering habits. H-109, New Guinea 24B, B–247, P. B. 117, P. B. 119, Pampanga Purple, Cebu Purple, Badila, and Luzon

White represented the thick soft type. The number of tillers ranged from two to seven stalks to the hill. New Guinea 24B produced an average of two stalks to the hill; P. B. 117, 3 stalks; P. B. 119, 4 stalks; B–247, Badila, and Luzon White, 5 stalks each; H-109 and Pampanga Purple, 6 stalks each; and Cebu Purple, 7 stalks. The nine varieties of soft thick type gave an average of 5 stalks to the hill.

Of the thin hard type, Chinois, Toledo, C. A. C. 87, Japanese Cane, Uba, and Hind's Special were planted. The average number of the stalks to the hill ranged from 11 to 22. Toledo yielded 11 stalks to the hill; Japanese Cane, 12 stalks; Hind's Special, 14 stalks; C. A. C. 87, 17 stalks; Chinois, 18 stalks; and Uba, 22 stalks. The six varieties of the thin hard type gave an average of 16 stalks to the hill which is more than three times the average of the number of stalks to the hill of the thick soft type.

SUMMARY AND CONCLUSIONS

1. It was found necessary to have some knowledge about which varieties flower and which do not and the flowering habits and flower characteristics of the different varieties before potting was done.

2. Potting a stalk could be done on a portion of a stalk either 30 cm. above the ground or just above the surface. A pollen-sterile variety should be potted purposely as "mother" while a pollen-fertile one should be potted preferably as "father".

3. The thick soft type of canes which was potted three or four weeks before flowering sent out roots earlier than the thin hard type. The thick hard type had abundant roots three weeks after potting and the thin hard one a month or so after. The production of roots of the thin type was slow. To grow normally, the potted stalks needed good care.

4. By the use of potted plants for crossing, bagging can be dispensed with and the plants are kept free from undesirable pollen.

5. The normal potted plants flowered, their anthers dehisced, and seeds matured at the same time as with canes growing in the field.

6. Sugar cane stalks rooted very easily. Rooting is a good substitute for the checkerboard system of planting. In the checkerboard planting there was a varietal struggle for existence in the first and subsequent ratoons. Besides, all varieties planted by this method do not flower at the same time, hence it is not always advisable. Isolated stalks can be taken to any convenient place for pollination and are easily protected from destruction by animals. Rooting of canes would be a good method for studying the asexual inheritance of sugar cane.

RECOMMENDATION

The writer recommends the following precautions in potting, if one desires to be successful.

Knowledge as to which varieties flower and which do not is very important for a cane breeder before he attempts to pot canes. Otherwise,

his work is hit-or-miss and much time, labor, and expense is wasted. Before potting, a plant breeder should also know the habits and characteristics of the cane flowers that he may avoid potting stalks that can not be used for pollination work.

The potting materials should be prepared before potting. Select healthy and disease-free sugar cane stalks that have a clear indication of flowering. Stalks from a disease infected stool although they appear healthy should not be potted. To facilitate the potting operation two men should work together.

In repotting one should be very careful not to injure the newly developed roots. Repotting should be done in the breeding shed, for it would be difficult to carry the heavy pots from one place to another.

The success of potting depends principally upon the method and the care and treatment of the potted stalks. The transpiration of the cut stalks should be reduced. Unless good care is given to the plant no seeds will be obtained. On the other hand, if the potted stalks function normally, the production of seeds is not hindered. If the arrows are found growing, the stalks can be used for breeding operation.

THE EFFECTS OF DRY HEAT ON WEEVILS IN CORN AND ON CORN SEEDS[1]

ENRIQUE M. PALLER

WITH TWO TEXT FIGURES

INTRODUCTION

Corn grains when attacked by weevils, either in the field or storage, become useless for seed and food purposes. One of the most serious problems in the storage of corn is the control of weevils. Many substances, such as carbon bisulphide, cyanide gas, and copper carbonate dust have been used to kill these harmful insects but the application of heat has not been widely used.

It is important to know the lethal temperatures for weevils in corn when using dry heat for their control and also its effect on the viability, vitality, and productivity of corn. This knowledge will determine how far dry heat may be used in protecting corn grain in storage and in mills from weevils.

Review of literature

There are a number of workers who have investigated the use of dry heat for the control of weevils in cereals and stored grains. Also several investigators have worked on the effect of dry heat on the viability of cereal seeds.

According to Dean (1911) the French long ago knew the value of heat in the control of insects attacking stored grains. They devised "insect mills" which they used in heating the infested grain. He reports that Prof. F. H. Chittenden states in his paper on "Insects Injurious to Grains" that prior to the adoption of carbon disulphide as a fumigant, heat was relied upon in the destruction of insects attacking grains in storage. Dean found in his investigation that weevils are killed when subjected to a temperature of from 105°F. (40.6°C.) to 120°F. (48.9°C.) for from four to five hours a day for several days. He believes that the eggs of mill insects perish before the larvae stage and that a temperature of 115°F. (46.0°C.) for twelve hours proves fatal to the insects in their various stages. For example, 118°F. (47.8°C.) is fatal to the adults of *Calandra oryzae* Linn. and 122°F. (50.0°C.) in eleven minutes is fatal to all stages of *Tribolium confusum* Duv. According to this authority, the larvae, pupae, and adults

[1] Thesis presented for graduation, 1927, for the degree of Bachelor of Agriculture from the College of Agriculture No. 280; Experiment Station contribution No. 586. Prepared in the Department of Agronomy under the direction of Dr. Toribio Vibar.

of *Silvanus surinamensis* Linn., *Ephestia kuehniella* Zell, and *Tenebrioides mauritanicus* Linn. are killed when subjected to 120°F. (48.9°C.) for three minutes.

Shafer (1911) in his comment on the article of Dean on "Heat as a Means of Controlling Mill Insects", states that one of the best methods of fixing insects is by heat. He maintains that the parts of an insect can be fixed more quickly by heat, perhaps, than by any other method that has yet been found. When the tissues of an insect are fixed all the way through, it dies.

Goodwin (1922) expresses the belief that larvae, pupae, and adults of insects infesting cereals vary in the intensity of heat required to kill them. He states that a much higher temperature is required to destroy the larva, pupa, and adult than is required for the eggs. His reports show that weevils in chestnut, corn, and ash are killed when subjected to 120 to 125°F. (48.9 to 51.7°C.) for from two to three hours. A temperature of from 130 to 140°F. (54.4 to 60.0°C.) for four days or more will destroy practically all stages of cereal insects. Goodwin (1912) maintains that heat treatment is the most thorough method for the control of insects infesting flour mills. He claims that one treatment a year can completely rid the mill of insect pests and that it is not dangerous to human life, as are the fumigants.

According to Herrick (1914), if a temperature of 130°F. (54.4°C.) is maintained for several hours in a storeroom, the weevils in all the stages of life will be killed. Gossard (1911) reports that in the Kansas Agricultural Experiment Station, 118°F. (47.8°C.) was found to destroy the adults of rice weevil, *Calandra oryzae*. All stages of the saw-toothed grain beetle are killed at 119°F. (48.3°C.). Cadelle beetles perish if subjected to 120°F. for three minutes.

The Ohio Agricultural Experiment Station conducted a test on the different merits of various fumigants and heat for the control of granary and mill insect pests. The results of this test led to the recommendation of installing a heating system in mills.

Graham (1924), reports that temperature determines the rate of development, distribution, and in many cases, the percentage of mortality of *Ips pini* Say, *Monohamus scutellatus* Say, and *Chrysobothris dentipes* Germar. He found that the maximum death temperature of both the larva and adults of *Monohamus scutellatus* is 50°C.; *Ips pini*, 50°C. for the adult and 49°C. for the larva; and for the adult of *Chrysobothris dentipes*, 52°C. According to Doane (1924), 18°F. (–7.8°C.) for four minutes is fatal to all stages of Mediterranean flour moth. He reports that 181°F. (82.9°C.) proved detrimental to all stages of bran beetle, *Echocerus cornutus* Fab. Larson and Fisher (1924) state that during a heavy period of emergence, a temperature of 100°F. (37.8°C.) caused the weevils to leave the bag of seeds soon after emerging.

Dean (1911) reports that wheat can be subjected to a temperature of 150°F. (65.6°C.) for a short time without destroying its germinating power. Goodwin (1922) found that wheat heated at 150°F. (65.6°C.) for two hours germinated as well as the untreated seed. He said that corn subjected to a temperature of 140°F. (60.0°C.) for two days germinated as well as the untreated lot. It was found in the Ohio Agricultural Experiment Station that wheat can be heated at 150°F. (65.6°C.) for eight hours without injuring its germinating qualities.

Larson (1924) expresses the belief that when bean seeds are attacked by weevils, *Bruchus obtectus* Say and *B. quadrimaculatus* Fabr., there follows: (*a*) Destruction of germination; (*b*) acceleration of decomposition of seeds during germination; (*c*) prevention of development of primary leaves; (*d*) removal and making unavailable much of the plant food.

The experimental tests of Hinds and Turner (1911) show that the injury by weevils affects vitally the percentage of germination of corn seed. The badly infested seeds gave zero per cent germination. These authors report that corn badly infested with weevils is almost worthless, since hogs, horses, and mules will not eat it. They further report that weevil injury is responsible, to a considerable extent, for the irregular stand and lack of uniformity in normal growth in badly infested fields. They maintain that in the United States the injury caused by *Calandra oryzae* seems to be one of the factors which has restricted the raising of corn and the production of live stock and has tended to promote the one crop system of cotton culture.

Goodwin (1922) expresses the belief that the attacks of insects on stored cereals causes them to become insanitary as food, and this is responsible for mill owners having large financial losses.

Rosefeld (1911) states that in Louisiana during 1908 and 1909, *Calandra oryzae* was one of the commonest insects injurious to food stuff. Weevils are reported by various authorities to be one of the most destructive insect pests in stored grains in United States, Java, India, and in the Philippines.

Objects of the present work

The objects of the present work were: (*a*) To determine the effect of dry heat on weevils in corn; (*b*) to determine the lethal temperature for weevils attacking corn grains; (*c*) to determine the effect of dry heat on the viability, vitality, and productivity of corn; and to determine to what extent dry heat can be used in the control of weevils in stored corn.

Time and place of the present work

The work was carried on in the College of Agriculture, from June 1924 to March 1926, a period of one year and nine months.

MATERIALS AND METHODS

Materials

The following materials were used in the present work: (*a*) Weevil infested corn seeds; (*b*) good seeds of Calauan Yellow Flint, Moro, Mexican June, Ferguson, Australian Yellow Dent, Baluga, Cebu, Los Baños Yellow Dent, Cagayan Yellow Flint, Diquet, sweet corn, and pop corn; (*c*) heating apparatus consisting of one box, one oven, two table lamps and two thermometers. (See figure 1.)

Procedure

Determination of the lethal temperature for weevils in corn. Weevil infested corn grains were heated inside the box. Two ordinary table lamps were used in heating the oven. The weevil-infested corn grains were gradually heated to 45°C., 50°C., 55°C., 60°C., 65°C., and 70°C. These temperatures once reached, were kept constant for different periods of time.

The weevil-infested corn was subjected to different temperatures for different periods of time as follows:

1. Heated to 45° C. for 15 minutes.
2. Heated to 50° C. for 15 minutes.
3. Heated to 55° C. for 15 minutes.
4. Heated to 60° C. for 15 minutes.
5. Heated to 65° C. for 15 minutes.
6. Heated to 70° C. for 15 minutes.

Three lots for each of these six temperatures were exposed for 30, 45, and 60 minutes. The period of exposure to heat was adjusted to determine as nearly as possible the length of time necessary to heat the weevils in each lethal temperature. Ten trials were made in each treatment to determine the lethal temperatures for the weevils.

The heating and observation. The weevil-infested corn grains were put in ordinary cigar boxes 22.9 cm.×15.8 cm.×7 cm. and then heated. The same amount of weevil-infested corn grains was used in each treatment throughout the experiment. The weevils were taken from the oven at the end of the time of exposure to heat. When the weevils appeared dead, the heated weevil-infested corn was allowed to cool and then was put in well-corked bottles for observation during one year. This procedure was to determine whether or not the larva and pupa were killed and to be sure that the adults were dead.

Regulation and control of heat. Since it is difficult to maintain a constant temperature in the oven used, the writer devised a simple heating apparatus (see fig. 1). It consisted of a box 73 cm. long, 46 cm. wide, and 48 cm. thick. The box had four openings. One, the door, was large enough to admit the oven and was closed by a board which could be easily removed. Above the door was the window, 12 cm.×5.5 cm. This was closed by a

piece of cardboard which could be opened and closed. Below the door was another opening, 32.5 cm.×6.5 cm. which was never closed. This opening was for the draft of air and for making the adjustment of the wicks of the lamps easy. At the top of the box was another window, 31×3 cm. covered by a board which could be closed and opened. This heating apparatus lessened to a great extent the variation of temperature in the oven and thus

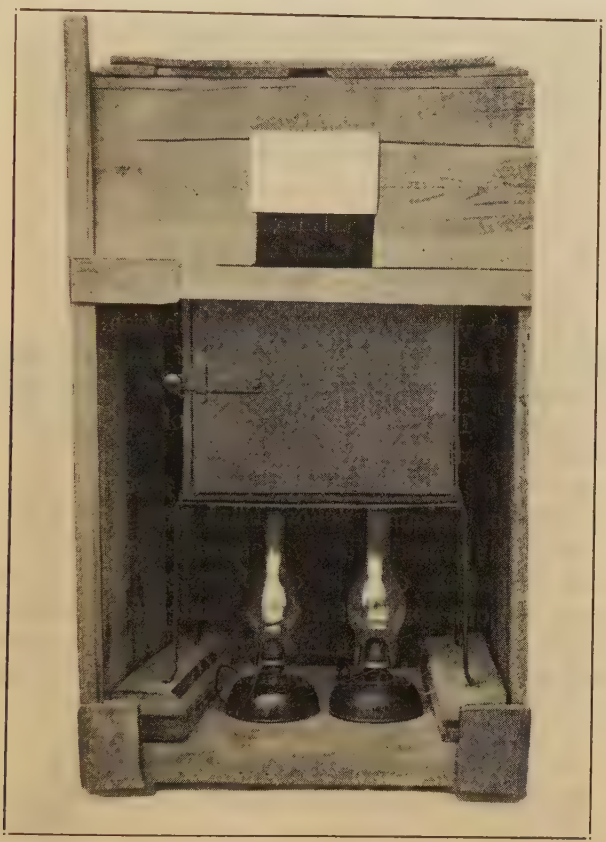

Fig. 1.—Heating apparatus, open, showing the oven and lamps. Note the thermometer through the window.

made the control of temperature more efficient. The writer found that constant temperature could be maintained for several hours in this apparatus.

The heat or temperature was regulated and controlled through the adjustment of the wick of the lamps. When the oven was over-heated, the temperature was lowered by opening the windows and the door and turning down the wick of the lamps. The wick of the lamps could be adjusted easily through the opening at the lower side of the front of the box.

Two thermometers were inserted at the top of the oven. The reading of these thermometers could be easily taken through the window. The valves of the thermometers were placed near the weevil-infested corn in the oven.

Determination of the effect of dry heat on the viability and vitality of corn seeds. Good seeds of the varieties Calauan Yellow Flint, Moro, Mexican June, Ferguson, Australian Yellow Dent, Baluga, Cebu, Los Baños Yellow Dent, Cagayan Yellow Flint, Diquet, sweet corn, and pop corn were heated as follows:

First set

1. To 45° C. for 30 minutes.
2. To 55° C. for 30 minutes.
3. To 65° C. for 30 minutes.

Second set

1. To 45° C. for one hour.
2. To 55° C. for one hour.
3. To 65° C. for one hour.

Fifty seeds of each variety were used for each treatment. The treated seeds were germinated in uniform soil in boxes of uniform size. There was one control for each variety. The percentage of germination for each variety was recorded. The average dry weight of seedlings of each variety was taken when they were one week old.

Determination of the effect of dry heat on the productivity of corn. Five hundred good seeds of Calauan Yellow Flint were heated in two sets as given under the viability and vitality determination. The treated seeds were planted in rows at the distance of 75 cm. each way with three seeds to a hill. There was one control for seeds heated for 30 minutes and one for seeds heated for one hour. One hundred plants were selected at random from every treatment and from the control. The height, weight of straw, and weight of ear of the 100 plants were taken at maturity.

RESULTS AND DISCUSSION

The lethal temperatures for weevils in corn seed.

Table 1 shows that of the weevils in corn seeds, rice weevil, *Calandra oryzae*, granary weevil, *Calandra granaria*, and the confused flour-beetle *Tribolium confusum* perished when heated gradually to 50°C. for 45 minutes, 55°C. for 20 minutes, 60°C. for 10 minutes, and less than a minute at 65°C.[2] Not only the adults but also the larvae and pupae perished at these lethal temperatures. The heated weevil-infested corn seeds with the dead weevils

[2] For description of these weevils see:

Back, E. A., and R. T. Cotton, 1922. Stored grain pests. U. S. Dept. Agric. Farmers' Bull. 1260: 2–47;

Forbes, Stephen A. 1912. Noxious and beneficial insects in the State of Illinois. Twenty-seventh report of the State Entomologist of Illinois. 1–43: 52 fig.

Herrick, Glenn W. 1914. Insects injurious to household and annoying to man. xvii + 470 p., 160 fig. New York: The Macmillan Company.

were allowed to cool and were then put in well-corked bottles for observation. The one-year observation revealed that not a single weevil survived or developed. No living insect was observed.

TABLE 1

Showing the lethal temperatures for Calandra oryzae, Calandra granaria, and Tribolium confusum in corn

NUMBER	LETHAL TEMPERATURES	
	Temperature	Time of exposure to heat
1	50° C.	45 minutes
2	55° C.	20 minutes
3	60° C.	10 minutes
4	65° C.	Less than 1 minute

The weevils subjected to the temperature of 45°C. for six hours, 50°C. for 40 minutes, 55°C. for 15 minutes, and 60°C. for 5 minutes became very weak and some of the adults and larvae appeared to be dead. The corn infested with these weevils was put in well-corked exhibition bottles and treated in the same manner as that subjected to the lethal temperature. This was done to determine whether or not the condition in the bottles was favorable for the recovery of the weevils. At the end of one week, the adults became active and living larvae were found in the bottles. At the end of the second, third, fourth, fifth, and sixth months, many active adults and living larvae were found in each bottle. Ten trials were made in each treatment and observations showed that the weevils were able to recover.

The weevils when subjected to the lethal temperatures did not recover, but when they were subjected to the same temperatures, but with shorter time of exposure, the weevils were able to recover. This leads to the conclusion that the weevils perished when subjected to the lethal temperatures. Table 1 shows that the length of exposure in the lethal temperatures decreases as the temperature becomes higher.

The weevils tend to come out from their hiding places when the corn is heated. Both the adults and the larvae become more and more uneasy (move here and there) as the temperature and length of exposure to heat increase. This uneasiness continues until they become exhausted and die from the effects of the heat.

The effect of dry heat on the viability and vitality of corn seed

The viability and vitality of corn seed were not affected when it was heated to the temperatures that killed the weevils. The study of tables 2 and 3 leads to the conclusion that the viability and vitality of the seeds of Calauan Yellow Flint, Moro, Mexican June, Ferguson, Australian Yellow

Dent, Baluga, Cebu, Los Baños Yellow Dent, Cagayan Yellow Flint, Diquet, sweet corn, and pop corn, were not affected when heated to 45°C., 55°C., and 65°C. for 30 minutes or for one hour.

TABLE 2

Showing the effect of dry heat on the germination of corn

VARIETIES OF CORN	TREATMENT						
	Exposed for 30 minutes			Exposed for one hour			Control
	45°C.	55°C.	65°C.	45°C.	55°C.	65°C.	
	Germination			Germination			Germination
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Calauan Yellow Flint	100	100	100	100	100	100	100
Moro	100	100	100	100	100	100	100
Mexican June	100	100	100	100	100	100	100
Ferguson	100	100	100	100	100	100	100
Cebu	100	100	100	100	100	100	100
Baluga	100	100	100	100	100	100	100
Gagayan Yellow Flint	100	100	100	100	100	100	100
Los Baños Yellow Dent	100	98	100	100	94	100	100
Australian Yellow Dent	80	82	80	78	82	80	80
Diquet	90	92	88	88	90	92	90
Sweet Corn	80	82	82	80	80	82	82
Pop Corn	82	80	82	80	78	82	80

TABLE 3

Showing weight of seedlings of corn treated with dry heat

VARIETIES OF CORN	TREATMENT						
	Exposed for 30 minutes			Exposed for one hour			Control
	45°C.	55°C.	65°C.	45°C.	55°C.	65°C.	
	Average weight of seedling			Average weight of seedling			Average weight of seedling
	grams	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*
Calauan Yellow Flint	.0890	.0880	.0870	.0900	.0870	.0940	.0920
Moro	.0870	.0843	.0843	.0831	.0820	.0831	.0811
Mexican June	.0900	.0860	.0880	.0800	.0801	.0840	.0830
Ferguson	.0923	.0939	.0923	.0900	.0940	.0923	.0939
Australian Yellow Dent	.0834	.0842	.0846	.0923	.0809	.0834	.0823
Cebu	.0858	.0849	.0808	.0882	.0880	.0865	.0832
Baluga	.0910	.0880	.0963	.0901	.0992	.0905	.0928
Los Baños Yellow Dent	.0963	.0981	.0974	.0904	.0921	.0933	.0919
Cagayan Yellow Flint	.0863	.0807	.0854	.0880	.0828	.0834	.0834
Diquet	.0822	.0802	.0801	.0881	.0844	.0863	.0834
Sweet Corn	.0712	.0729	.0720	.0735	.0720	.0738	.0738
Pop Corn	.0623	.0625	.0636	.0626	.0601	.0636	.0625

Table 2 shows that the percentage of germination of the treated and the untreated seeds was about the same. The temperatures 45°C., 55°C., and 65°C. for 30 minutes and for one hour did not affect the germinating power of the corn seeds. The percentage of germination of Calauan Yellow Flint, Moro, Mexican June, Ferguson, Cebu, Cagayan Yellow Flint, and Baluga was 100 per cent in both the treated and the untreated seeds. The Diquet and the pop corn when heated to 65°C. for one hour had a germination 2 per cent higher than the control. Under this same treatment, the Australian Yellow Dent, Los Baños Yellow Dent, and sweet corn gave the same percentage of germination as the untreated. When heated to 65°C. for one hour, Los Baños Yellow Dent gave a germination 6 per cent higher than when heated to 55°C. for the same length of time. Under the same treatment Diquet and sweet corn gave 2 per cent higher germination and pop corn 4 per cent higher. Observation revealed that the treated seeds germinated as uniformly as the control. The seeds from the treated and from the untreated seeds gave practically the same stand.

Table 3 shows that the average weight of seedlings of Calauan Yellow Flint, Moro, Mexican June, Ferguson, Australian Yellow Dent, Baluga, Cebu, Los Baños Yellow Dent, Cagayan Yellow Flint, Diquet, sweet corn, and pop corn was not affected when heated to 45°C., 55°C., and 65°C. for 30 minutes and for one hour. This result indicates that the corn plant was not affected by the heat treatment given, in so far as the weight of the seedling was concerned. The Ferguson variety when heated to 65°C. for one hour gave a higher average weight of seedling than the control. When heated to 45°C., and 65°C. for 30 minutes and to 45°C. and 65°C. for one hour it gave a lower average weight of seedling than the control. Seeds heated to 55°C. and 65°C. for one hour gave a higher average weight of seedling than the seeds heated to 45°C. for the same period of time.

When heated to 45°C., 55°C., and 65°C. for 30 minutes and to 65°C. for one hour, Mexican June variety gave a higher average weight of seedling than the control. With the same variety, seeds heated to 45°C. and 55°C. for one hour gave a lower average weight of seedling than the untreated seeds. The seeds heated to 65°C. for 30 minutes gave a higher average weight of seedling than those heated to 55°C. for the same period of time. The seeds heated to 65°C. for one hour gave a higher average weight of seedling than the seeds heated to 45°C. and 55°C. for the same length of time.

The sweet corn when heated to 65°C. for one hour gave seedlings of same average weight as the untreated seeds. The seeds when heated to 45°C., 55°C., and 65°C. for 30 minutes and to 45°C. and 55°C. for one hour gave a lower average weight of seedling than the untreated seeds. The seeds heated to 55°C. for 30 minutes and to 45°C. and 65°C. for one hour gave a higher average weight of seedling than the seeds heated to 45°C. and 65°C. for 30 minutes and to 55°C. for one hour.

When heated to 65°C. for 30 minutes and to 45°C. and 65°C. for one hour, the pop corn seed produced a higher average weight of seedling than the untreated seeds did. When heated to 45°C. for 30 minutes and to 55°C. for one hour, the average weight of seedling was lower than from the untreated seeds. The seeds heated to 55°C. for 30 minutes and the untreated seeds had the same average weight of seedling. The seeds heated to 65°C. for 30 minutes and to 65°C. for one hour produced a higher average weight of seedling than those heated to 45°C. for 30 minutes and to 55°C. for one hour.

When the seeds of Calauan Yellow Flint corn were heated to 65°C. for one hour, the average weight of seedling was higher than with the untreated seeds. The seeds heated to 45°C., 55°C., and 65°C. for 30 minutes and to 45°C. and 55°C. for one hour gave a lower average weight of seedling than the untreated seeds did. The seeds heated to 45°C. and 65°C. for one hour gave a higher average weight of seedling than the seeds heated to 45°C., 55°C., and 65°C. for 30 minutes and to 55°C. for one hour.

The same effect on the average weight of seedlings was true of Australian Yellow Dent, Diquet, Cebu, Los Baños Yellow Flint, Moro, and Baluga. All these data show that the heat treatment given the seed did not affect its viability and vitality.

Effect of dry heat on the productivity of corn

It is evident from table 4 that the temperatures and exposures fatal to corn weevils do not affect the productivity of corn. The production of neither the wet nor the dry season planting was affected when the seeds were heated to 45°C., 55°C., and 65°C. for 30 minutes and for one hour. It was found under this treatment that the seeds of Calauan Yellow Flint produced plants as vigorous and productive as the untreated seeds in both the wet and dry season plantings. For, while actual differences were registered in the average height of plants, and in the average weight of straw and of ear of the heated and untreated seeds, these differences were of no practical significance (see table 4).

Actual observations in the field showed that the plants in the treated and untreated rows were similar. The general appearance and color of the plants from the treated and untreated seeds in the wet and dry season plantings were observed to be similar. In dry season planting where the corn grew well, the plants from both the treated and untreated seeds were vigorous and tall. The plants in the wet season planting were not so good as in the dry season, but the plants from the treated and untreated seeds behaved similarly. This shows that the corn was not affected by the heat treatment given.

TABLE 4

Showing the effect of dry heat on the productivity of Calauan Yellow Flint corn

TREATMENT		WET SEASON PLANTING			DRY SEASON PLANTING		
Temperature	Length of exposure to heat	Average height of plant	Average weight of ear	Average weight of straw	Average height of plant	Average weight of ear	Average weight of straw
	min.	*cm.*	*grams*	*grams*	*cm.*	*grams*	*grams*
45° C.	30	153.9 ±1.1507	34.25±0.9025	29.04±0.6218	222.9 ±1.3854	100.66 ±1.9337	91.340
55° C.	30	150.91±0.8296	33 65±1.0745	25.41±0.5267	222.88±1.6660	94.90 ±2.0673	97.099
65° C.	30	153.98±1.0617	38.95±1.0165	26.17±0.5274	223.48±0.9821	94.065±2.4012	96.935
Control		153.14±1.2006	37.84±1.0509	28.88±0.6576	227.39±1.2289	100.066±1.7611	92.944
45° C.	60	153.81±1.0873	38.89±1.1345	33.30±0.8363	231.32±1.5291	97.00 ±1.7683	90.999
55° C.	60	153.07±1.2343	34.84±1.2095	26.87±0.4376	219.87±1.0972	99.47 ±1.8731	99.530
65° C.	60	157.8 ±1.2343	37.98±1.0792	26.73±0.5978	221.52±1.0522	101.139±2.1201	93.861
Control		149 64±0.9956	34.13±1.1305	26 75±0.5605	210.80±0.9322	99.56 ±1.2779	94.630

SUMMARY OF CONCLUSIONS

1. The lethal temperatures for weevils *Calandra oryzae* Linn., *Calandra granaria*, and *Tribolium confusum* Duv. which attack corn grains are:
   (a) 50°C. for 45 minutes.
   (b) 55°C. for 20 minutes.
   (c) 60°C. for 10 minutes.
   (d) When heated at 65°C. for even less than 1 minute.

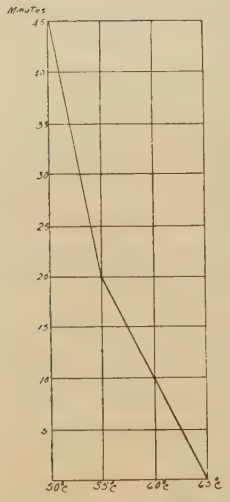

Fig. 2.—Showing the lethal temperatures for weevils in corn seed.

2. At these lethal temperatures the larvae, pupae, and adults of *Calandra oryzae, Calandra granaria*, and *Tribolium confusum* perish.
3. The viability and vitality of the seeds of Calauan Yellow Flint, Moro, Mexican June, Ferguson, Australian Yellow Dent, Cagayan Yellow Flint, Baluga, Cebu, Los Baños Yellow Dent, Diquet, sweet corn, and pop corn were not affected when heated to 45°C., 55°C., and 65°C. for 30 minutes or for one hour.
4. The productivity of Calauan Yellow Flint corn was not affected when heated to 45°C., 55°C., and 65°C. for 30 minutes or for one hour.
5. Corn grains can be heated 65°C. for one hour without injury.
6. Corn seeds can be heated (dry heat) to a temperature sufficient to kill weevils attacking them without affecting their viability, vitality, or production.
7. Dry heat can be safely used as a means to control weevils attacking corn in storage and in mills.

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A REVIEW: "COMMERCIAL TIMBER TREES OF THE MALAY PENINSULA" [1]

This publication should be of great value to tropical forestry. The identification of forest trees in the tropics is still quite a problem because of the numerous species with slight differences. But the author of this book seems to have discovered a feasible or practical remedy for this difficulty. His key to the identification of Malayan trees, based on bark characteristics, is well worthy of study with the object of adapting it to Philippine species.

In the first part of the book, the author gives the methods used and after describing the territory, the climate and the population, he discusses in a general way the forests of the Malay Peninsula. He groups them into three classes, namely: littoral forest, lowland forest, and hill forest. The most important of these is the lowland forest which extends from just behind the littoral forest to an elevation of about 2,000 feet. This forest is composed of several storeys. The first, or top storey is made up of very large trees, mostly of the family Dipterocarpaceae, whose crowns start at 60 to 100 feet or more above the ground. Like in the Philippine forests, the big volume of trees is in the family Dipterocarpaceae which constitute about 60 per cent of the stand. Next comes the family Leguminosae furnishing about 10.5 per cent of the volume of the timber produced. There are known so far about 2,500 species of trees in the forests of the peninsula.

The second part, or the greater portion of the book, deals at length with the principal commercial timber trees, giving the botanical descriptions of each; its silvicultural characteristics and economic value. Many of these trees are identical with those found in the Philippine Islands, and their growth habits will serve as an invaluable basis for comparison in our growth studies. The illustrations in the book are excellent. The growth data were taken from various sample plots established within the past 25 years by the Malayan Forest Department. The plots contain over 10,000 trees, representing more than 30 species.

Doctor Foxworthy, author of the publication, should be congratulated for having published such a valuable contribution to tropical forestry.

ADRIANO V. SANTOS
Of the Philippine Bureau of Forestry

[1] Foxworthy, F. W. 1927. Commercial timber trees of the Malay Peninsula. 195 p., 136 fig. and 1 map. Malayan Forest Records No. 3, Federated Malay States Government.

ABSTRACT[1]

Variability in important agronomical characters among seedling canes from parent varieties H-227, Louisiana Striped, Cebu Purple, and Badila. Vicente T. Florida (*Thesis presented for graduation, 1926, from the College of Agriculture No. 281; Experiment Station contribution No. 587*).—This work covered a period of about two years, from November 1924 to March 1926. True seeds were obtained from parent varieties Louisiana Striped, H-227, Cebu Purple, and Badila. These seeds were germinated in Standard Oil petroleum boxes in which was sterilized soil to a depth of about ten centimeters. The seedlings were transplanted to nursery plots when they were about 35 to 40 centimeters high. The space between plants was 75 by 50 centimeters. The plants numbered 1133. At the age of about a year these plants were harvested. The vegetative offspring and seedlings of these plants were again planted.

The important agronomical characters studied were total solids, height, and diameter of the main stalk of each stool, and the total number of millable stalks in each stool.

The results were discussed as follows:

The young seedlings of the different varieties used, although of the same age, showed great variation in the percentage of total solids.

About the same range of variability in the height of main stalks was found in the 1924 Louisiana Striped seedlings, in the 1925 P. B.[2] offspring; also in the 1925 P. B. asexual offspring and the H–227 1925 seedlings. The 1925 Cebu Purple seedlings manifested the widest range of variability.

The Louisiana Striped 1924 seedlings and Cebu Purple 1925 seedlings had about the same range of variation in the diameter of stalk. The same was true with the H–227 seedlings, H–227 P. B. asexual offspring, H–227 1925 seedlings, and Badila 1925 seedlings.

In the range of variability of millable stalks, a standard deviation of 11.033 ± 0.075 was obtained from the 1925 Louisiana Striped P. B. asexual offspring and only 1.778 ± 0.379 from the 1924 Louisiana Striped seedlings. There was no significant range of variability in the other seedlings. The H–227 1925 seedlings showed the greatest range of variability in the number of unmillable stalks.

The comparison made between the agronomical characters of the 1924 Louisiana Striped seedlings and the 1925 Louisiana Striped P. B. asexual offspring was as follows:

[1] Abstract prepared as part of the required work in English 6, College of Agriculture.

[2] Numbers with the "P. B." prefix indicate seedlings which have been selected for at least one time.

The percentage of total solids of the 1925 Louisiana Striped asexual offspring was 25.58 ± 0.098 and that of the 1924 Louisiana Striped seedlings was 16.78 ± 0.159. The difference between these two which is 5.80 ± 0.187 is significant and shows the effect of selection. The 1925 Louisiana P. B. offspring had a mean of 23.89 ± 0.019 and the 1924 Louisiana Striped seedlings, 15.80 ± 0.051 per cent. This result shows a significant difference and again it indicates the effect of selection.

The average weight of main stalks in the 1924 Louisiana Striped seedlings was 4.03 ± 0.027 kilograms and that of 1926 Louisiana P. B. asexual offspring was 1.96 ± 0.047 kilograms. Selection for this character was effective.

Selection for height of main stalk seemed to be effective only in the case of Louisiana Striped and for number of millable stalks in the case of H–227.

The selected individuals after the study of the seedlings raised in 1925 was finished are:

Two individuals, P. B. 151 and P. B. 152, were selected from among 284 Louisiana Striped seedlings; two, P. B. 153 and P. B. 154, from among 170 H–227 seedlings; three, P. B. 155, P. B. 156, and P. B. 157 from among 57 Badila seedlings; and three, P. B. 158, P. B. 159, and P. B. 160, from among 58 Cebu Purple seedlings.

—*Abstract by José O. Cruz.*

EXCHANGE NOTES

A simple test for determining rices that will prevent beriberi in human beings and polyneuritis in pigeons and other fowls has been developed by Dr. Edward B. Vedder, of the U. S. Army Medical Corps, stationed at Manila, and R. T. Feliciano, chemist of the Manila Bureau of Science. The rice grains are stained with an iodine solution, the starch granules taking on a blue color. The proportion of external layers, which remain unstained, and which contain the beriberi-preventing factor, may be determined with reasonable accuracy by simple inspection, report these investigators. This method is so quick that it may be used during the milling process to determine the degree of milling. A chemical index for beriberi-preventing rice was also determined.

—*Science.*

The agricultural college at the University of Illinois has assumed leadership in many ways, particularly in its farm management studies. It is now studying the difficult problem of agricultural readjustments, and could profitably undertake a study of the more extensive commercial use of farm products as raw materials for industry.

—*The Prairie Farmer* (Illinois).

Rice field day was held Colusa County, California, September 14.

Blackbirds are so numerous over the rice fields of Butte County that the sky is occasionally darkened and control of their numbers is eagerly sought.

Jesse Perkins, Evansville, Oregon, has a chicken with one head, two bodies and four legs. Its actions are those of a normal fowl.

—*California Cultivator.*

The influence of the high per capita registration of automobiles in the United States is evidenced in the fact that, whereas in the world as a whole there is one automobile to each 64 persons, when the cars and people in the United States are not taken into consideration, this ratio becomes one automobile to 277 persons.

The extremes of popular reception of automotive transportation are found in the United States, where the ratio is one car to each small group of 5 people, and in Ethiopia, where the presence of only 109 automobiles and about 10,000,000 inhabitants makes the ratio as one to 91,743.

The number of persons per automobile in nearby countries are as follows: United States, 5.1; India, 3,333; Japan, 1,525; Malaya, British, 113; Philippine Islands, 407; China, 21,062, Siam, 1,460; and Borneo, Dutch, 953.

—*Commerce Reports* (U. S. A.)

It is essential that human diet has bulk as well as food value. A diet consisting entirely of proteins and starches leads to constipation, but when a bulk or 'roughage' of cellulose is present, digestion proceeds on its normal course. A breakfast food manufactured from milled rice had a very low cellulose content, and thus was not an ideal food. The deficiency has been overcome by the introduction of a pure edible cellulose made from the hull of the rice. It is prepared by cooking the hull with strong caustic soda solution followed by a hydration treatment to reduce it to a physical form suitable for use as an edible material. In the final state it is a light, fine, mealy, material. It is odourless and tasteless, and has a mealy feel in the mouth. Analysis of the finally purified product shows it to be practically pure cellulose.

Tests on its dietary value have been carried out on various subjects. In all cases the cellulose added to the milled rice obviated the ill effects of a diet of pure milled rice. It is suggested that the cellulose content of other foods be augmented by the addition of this edible rice cellulose.

—*Tropical Agriculture.*

In keeping with the progress which has been made from year to year, the provisions for the Eighth Annual American Poultry Congress, to be held October 1 to 7 at Waterloo, Iowa, insures this stellar event of a ranking

as one of the preeminent expositions of America. The Poultry Congress will be held as in previous years, in connection with the Dairy Cattle Congress and the National Belgian Horse Show, thus insuring breeders of exhibiting their birds before more than 100,000 of the best farmers of the Middlewest.

—*California Cultivator.*

The valuable work of the Illinois agricultural college and experiment station is well illustrated by the many excellent articles from members of the staff which have appeared in PRAIRIE FARMER during the past few months. We have published these articles in the hope of helping to bring the information which they contained into more general use. Agriculture as organized at present is highly competitive. The man who succeeds is the one who most quickly learns improved methods and puts them into use.

—*The Prairie Farmer* (Illinois).

COLLEGE AND ALUMNI NOTES

Mr. Tei Ishii, assistant entomologist of the Agricultural Experiment Station, Nishigahara, Japan, is working in the entomological laboratory of this College. He expects to spend about three months here. Mr. Ishii has been on an entomological tour of the rice-growing countries of the orient in search of natural enemies of one of the rice-stem borers, *Chilo simplex* Butler, which is a serious pest in Japan.

The Secretary reports 25 new registrants for the second semester. The total enrollment for the College year, 1928-29 is 881.

The Los Baños Biological Club held its thirty-ninth scientific program in the Auditorium of the College of Agriculture on November 22, 1928.

The following papers were read and discussed:

"The cost of milk production at the College of Agriculture."
By Mr. Felix B. Sarao.

"Three methods of vitalizing the teaching of Philippine crops."
By Mr. Zósimo T. Montemayor.

"The trend of sexual and reproductive seasons among horses, cattle, water buffaloes, sheep and goats under Los Baños Conditions.—A preliminary report."
By Dr. Valente Villegas.

Among the articles of interest in the Forest School quarterly, *The Makiling Echo* issued in January are: "Forest Labor in the Philippines" by Forester, Carlos Sulit, and "Kaiñgin Problem in the Philippines" by O. W. Pflueger, Chief, Division of Investigation.

Mrs. V. R. Aborn of Whittier, California, a former student of Dean Baker's in Pomona College writes Professor Yule that she was invited a few weeks ago to speak before "The Journal Club" whose members are biology majors at Whittier College and took for her subject Dean Baker's work, especially in entomology. Mrs. Aborn further writes that at a recent banquet at Pomona College Dr. A. R. Davis, associate professor of plant pathology of the University of California in his talk said that the three men who most influenced him in his student days were Professor Baker, Doctor Cook, and Professor Bracket. Mrs. Aborn inclosed (unsolicited) a generous contribution to the Baker Memorial Fund.

The Mimics second play of the year was presented the evening of December 5. The production was "The Twelfth Commandment" by George St. Clair, formerly head of the Department of English, College of Liberal Arts, U. P., "Thou Shall Not Gamble" the twelfth commandment gives the key note of the play.

The Cast were:

Nena—Juan's wife	Concepción Estavillo
Anita—his sister	Máxima Mulimbayan
Sing—his cook	José Austria
Carlos—his brother-in-law	Domingo Regner
Juan—A well-to-do-planter	Onapre Casupang
Mariña—his friend	Gerónimo Pascua
Santos, Cruz } friends of Mariña	(Valentin Amon, (Vicente Fernandez
Pedro—Juan's servant	Sabas Tangco
A Bill Collector	Ruperto Ami
A Policeman	Miguel de Guzman

The presentation revealed competent work on the part of the Director, Miss Anne Cole and careful study and rehearsal on the part of the cast, which had been carefully selected. Each interpreted his part well, remarkably well, considering that it was the "premier" appearance of most of the cast. The character with few lines acted his part with the same care in interpretation as the major characters. Hence there were no weak parts. The director and each member of the cast merit warm commendation for their sincere efforts, as do the other members of the Mimics for their efficient assistance.

By request this play was repeated January 12.